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INNOVATION IN VISUAL COMPUTING
July 1999

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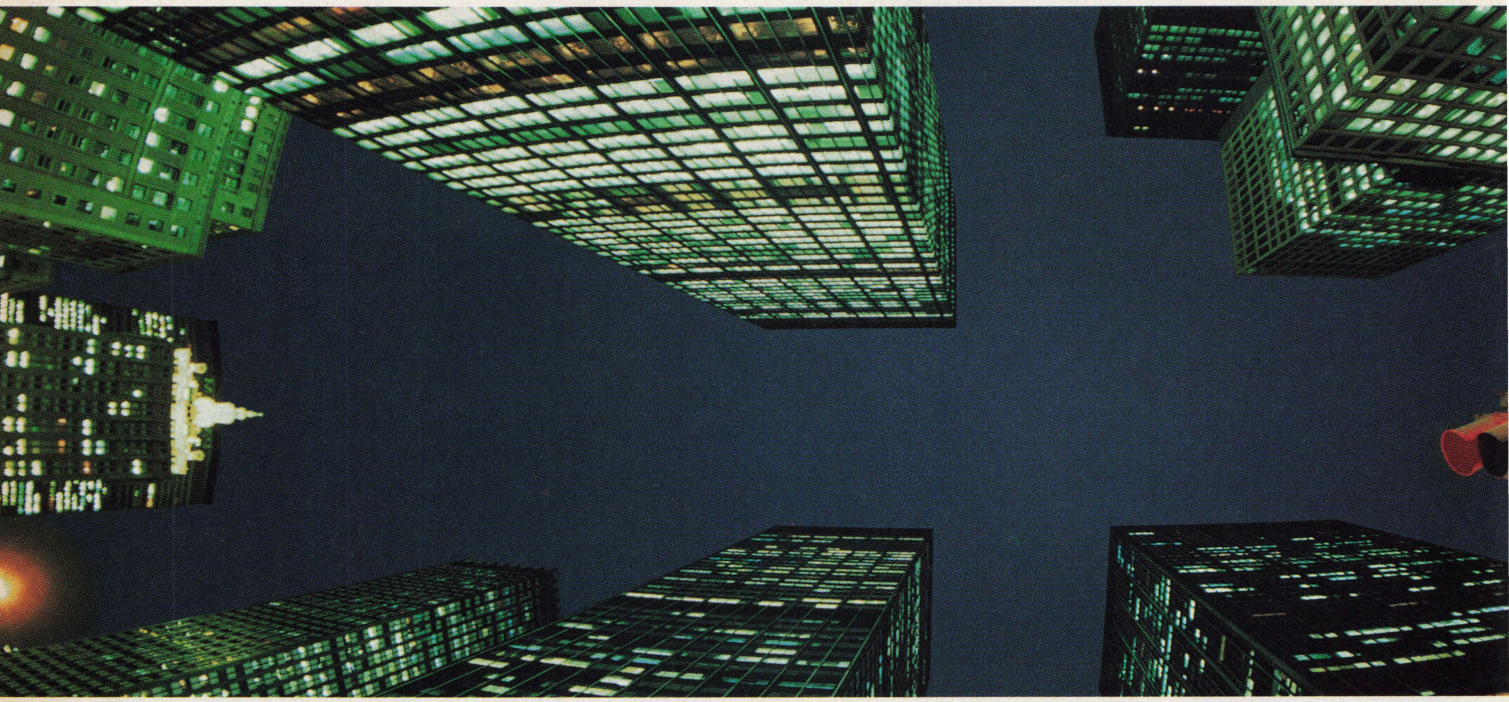

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Volume 22, Number 7
July 1999

CALL FOR ENTRIES
COMPUTER GRAPHICS WORLD
is accepting nominations for the
1999 INNOVATION AWARDS
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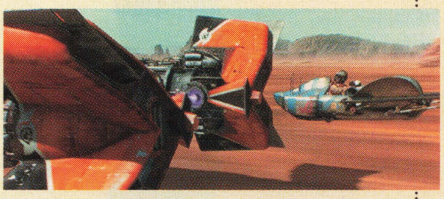

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© GM Design/Jay Bernard

ON THE COVER
GM stylist Jay Bernard used Studio Paint and Auto Studio from Alias|Wavefront to design the new Pontiac GTO concept car around an engineering model created with Unigraphics software. To read more about this and other retro car projects that blend the functions of stylist and designer, see page 23.

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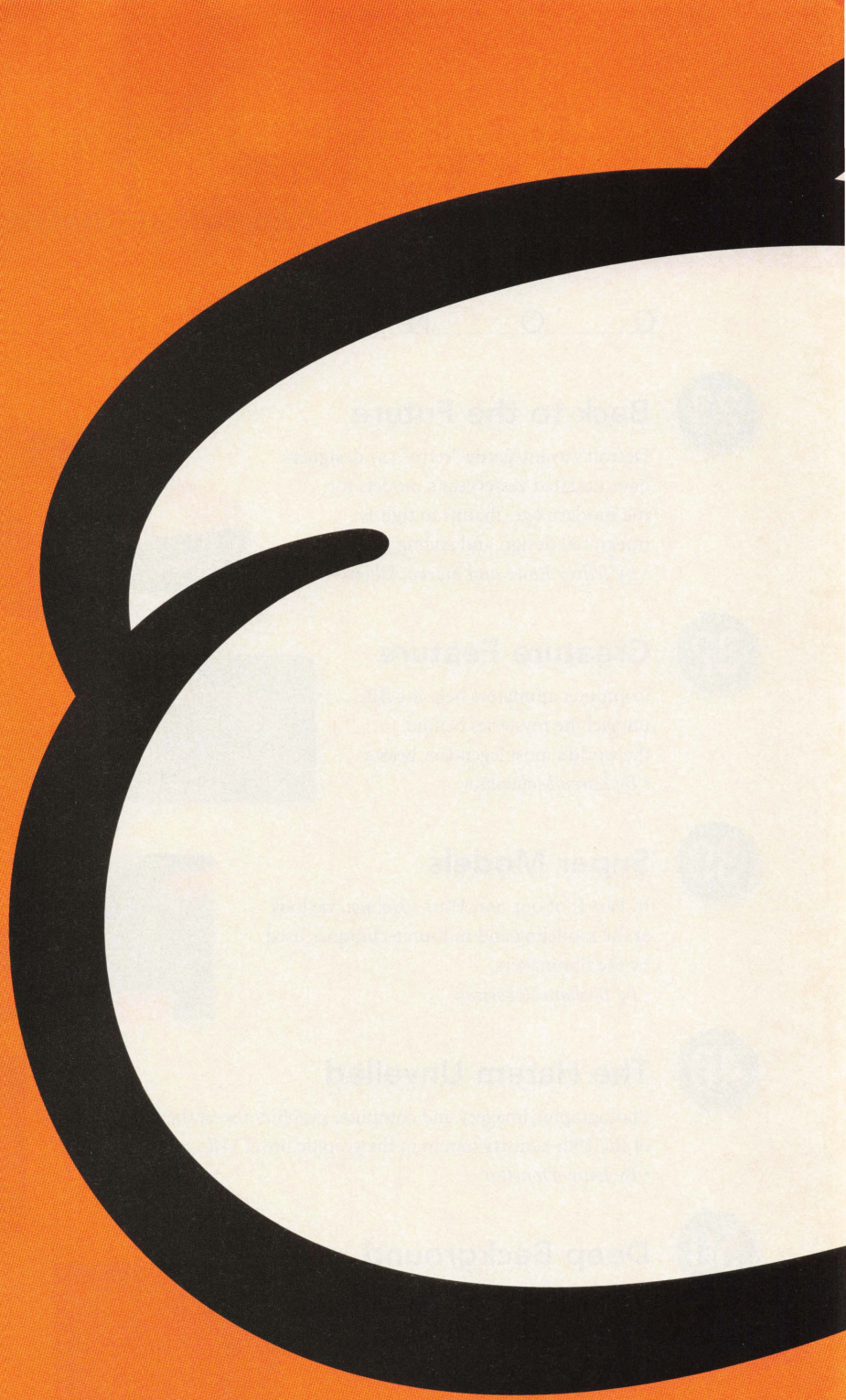

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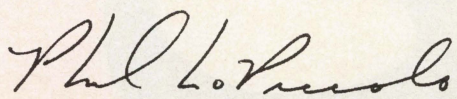
Leading Questions

One of my favorite conference sessions last year took place at the AEC Systems show in Chicago, where some of the biggest names in computer graphics and CAD—Joel Orr, Carl Machover, David Weisberg, and W. Bradley Holtz—teamed up to ask (but not answer) their top 20 Questions for the 21st century (see "Editor's Note," August 1998). Much to my delight, the same panel revisited the topic at the AEC Systems show this May in Los Angeles. As before, the group addressed CEOs of architectural and engineering firms, but their observations could be applied to the top executives of virtually any business enterprise. This time, in addition to identifying the most pressing questions, the panelists did more of what pundits naturally do best: share experiences, pass on insights, and offer advice. What follows is an annotated composite of their most thought-provoking comments regarding key questions facing CEOs today.

- ***How should a CEO view technology?*** One of the biggest mistakes executives make is to look at technology at a low level, such as asking whether designers can produce drawings at 15 hours per sheet rather than 20. Weisberg recalled asking a longtime CEO of a civil-engineering firm what technology was accomplishing for him: "I expected a litany of how his company was more productive"—able to do more work with fewer people—and, therefore, was more profitable. Instead, the CEO described several projects in which technology allowed his engineers to look at more alternatives and, as a result, create better highway designs than the state had originally proposed. He was so proud that his firm was using technology to meet the objectives of his organization, to produce something of true value, to improve the lives of people in his state. Weisberg recounted an old story: A man walks up to two workers doing the same job and asks them what they are doing. One says, "I'm a bricklayer, and I'm laying bricks." The other says, "I'm building a cathedral." Technology should be used to help people become cathedral builders, not just brick layers.
- ***What should CEOs view with alarm?*** Perhaps the biggest issue senior executives face is the declining skills of the workforce, which is caused by a disintegration of our education system. One problem is that students are so enamored of computers that they haven't learned to evaluate the answers they're getting, said Machover. With CAD systems, they often put down lines without knowing what they mean. Holtz noted that with slide rules, we had to make estimates, so we knew if we were in the ballpark. With computers, students plug in numbers and get answers that could be off by an order of magnitude.
- ***How can CEOs avoid failure?*** In his book *The Innovator's Dilemma*, Clayton Christiansen of Harvard University argues that many firms fail because they place too much stock in listening to their customers: Customers do not lead companies to innovation, but rather into refining existing products. In an era when technological innovation is what wins in the market, these companies are doomed. Of course, no one can predict exactly where innovation will arise. Seeds of innovation, like popcorn on a hot plate, are so scattered that no one can tell where or when the next one is going to pop or what shape it's going to take, noted Orr. Nevertheless, history shows us that innovation is more likely to emerge from small start-up organizations, from people with ideas for leading, not following, customers. In fact, CEOs should note that many of the best ideas were once rejected by large organizations—for which the innovators no longer work.



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LETTERS

Technology of 101 Uses

Your article, "A New Role for 3D Plant Models" (page 37, April 1999), mentioned a number of applications for 3D models, all of which my company employs, but left out one that we have been using successfully for a number of years.

With the AutoCAD program, we create large-scale 3D plant models for our clients that are computer-controlled

from a central console. We then use the models to create screen graphics for the control computer, which allows the operators to see actual renderings of the equipment while making adjustments and inputs to the systems. Our control engineers overlay appropriate icons onto the graphics for "pick and adjust" operations. Just one more reason for modeling plants in 3D.

William Eburn
President
Corporation XIDIX
Palm Bay, FL

But Will They Let Them in the Actors' Guild?

I am a Bachelor of Arts student at Curtin University of Western Australia. I've been conducting research into character animation and virtual actors, and your magazine has proved highly useful, and interesting as well. *Computer Graphics World* has educated me as to what software packages are actually being used in the industry, and also about the amazing scope and quality of the animation work being produced at this point in time.

One area of my research raises a question, however. Computer-modeled reproductions of actors have already proved useful as stunt doubles, but there have also been instances in which a celebrity's actual image or mesh has been copied without permission (such as Bill Clinton's appearance in the movie *Contact*). I was wondering whether other readers have an opinion with regard to this technology: Are virtual actors a boon or a threat to today's Hollywood actors?

Jonathan Bauer
Curtin University
Perth
Australia

Basement Modeling

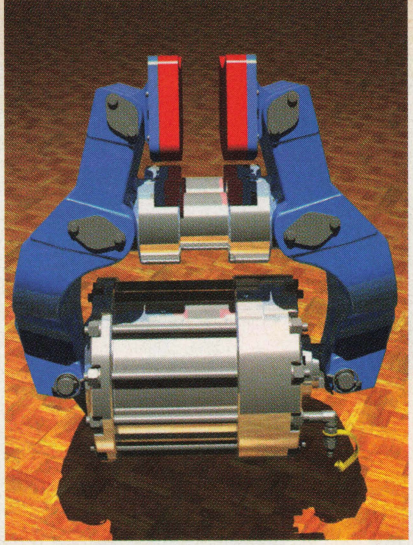
As one of a growing number of basement 3D artists, I enjoyed reading about Syth DeVoe, who has made the transition from hobbyist to professional (May 1999 Portfolio, page 50). I was reminded that it is possible to attain goals through patience and hard work.

I've been working with modeling programs for a bit more than a year and a half. So far, everything I have learned has been through books and bootstrapping. Volumes of reading and hours at the computer distill into two to three graphics per month. Now, with a seven-week-old Web site, and a need for part-time freelance work just to keep me in peripherals and upgrades, I realize that I've become part of the latest Gold Rush in our planet's history. The (W)ild, (W)ild, (W)eb offers many opportunities, and despite the enormous amount of competition and the difficulty in being "seen," it's exciting to be a part of it.

Ron Pfister
Pfister@imaginationmagic.com

A Solid View of Models

Not long ago, I was given a "go do" by my boss with respect to model-viewing software. He was fairly dissatisfied with the



product we had been using, so one of his prerequisites was that the model-viewing software I decided upon not be from that product's manufacturer.

Through a user's group to which I belong, I discovered "All Eyes on CAD," your article on model-viewing software in the May 1999 issue of *Computer Graphics World* (page 38), and I very much appreciated your summary of the different techniques and approaches to viewing models. After reading the article, I performed a Web search, using the words "Model Viewing Software," which eventually led me to download a trial version of Solid View from Solid Concepts (Valencia, CA), even though it wasn't mentioned in the piece.

Thanks to your informative article, I can now appreciate this particular program's capabilities with regard to the types of files it will view. Thank you for putting the explanation in user-friendly terms.

John P. Buck Jr.
Systems and Electronics
St. Louis, MO

We Value Your Input

We welcome any insights you may have that would further our readers' understanding of topics discussed in this issue. We may edit your response to conform to our style and space requirements. Please address letters to:

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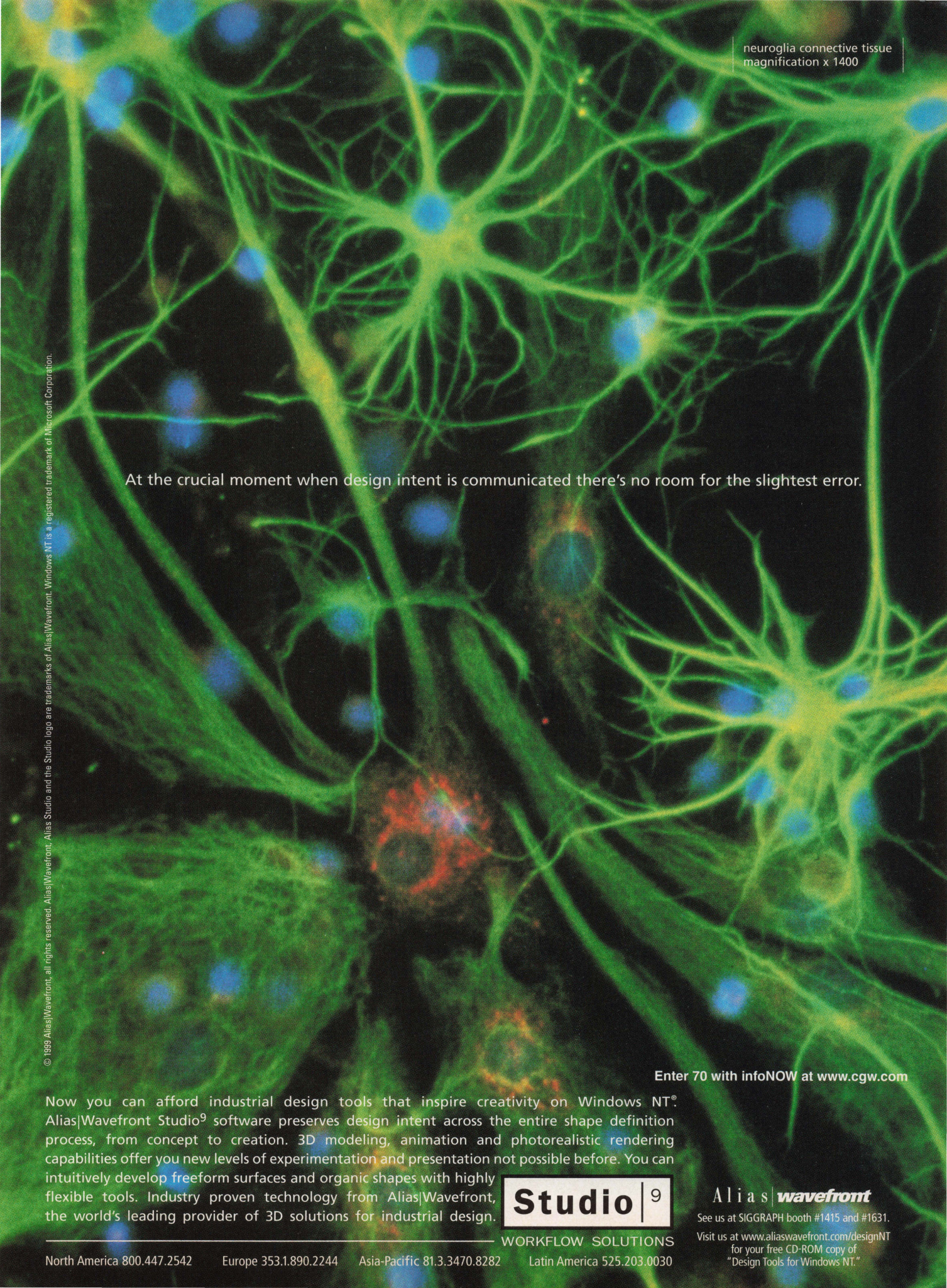
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SPOTLIGHT

The Shape of NURBS to Come

CAD users now have an easier way to create and integrate manufacturable organic shapes into their design processes. Raindrop Geomagic's latest product, geomagic Shape, automatically converts any polygonal surface to a NURBS model, obviating the need to set up cross sections or create patches one at a time. Along the way, the product preserves shape topology and adapts to local curvature. Users can specify the grid resolution depending on surface complexity, and verify the accuracy of the model in real time with regard to engineering constraints. The resulting models output to IGES 128 for integration with installed CAD systems.

"Shape will definitely save time in key areas of the CAD production process," says Wanda Meloni, senior software analyst with Jon Peddie Associates (Tiburon, CA). "One important advantage is that its conversion process is automatic."

Shape can be used as a stand-alone product, or in conjunction with Raindrop Geomagic's Wrap program, which automatically collects scanned data from an object and converts it to a polygonal model.

Geomagic Shape runs on an SGI workstation running Irix 6.3 or higher, with a recommended R 10,000 processor and 256MB of memory; or a Pentium II machine (333MHz recommended) running Windows 95/98/NT, with 256MB of memory. The program is scheduled to ship this summer at a price of $14,900.

— Jenny Donelan

(Research Triangle Park, NC; 800-251-5551; www.geomagic.com)

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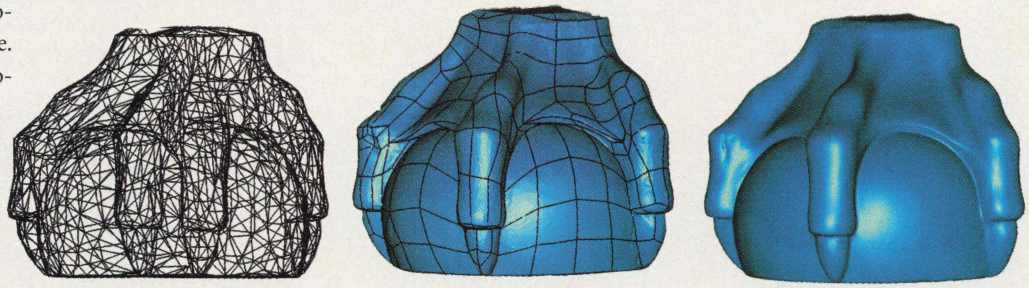
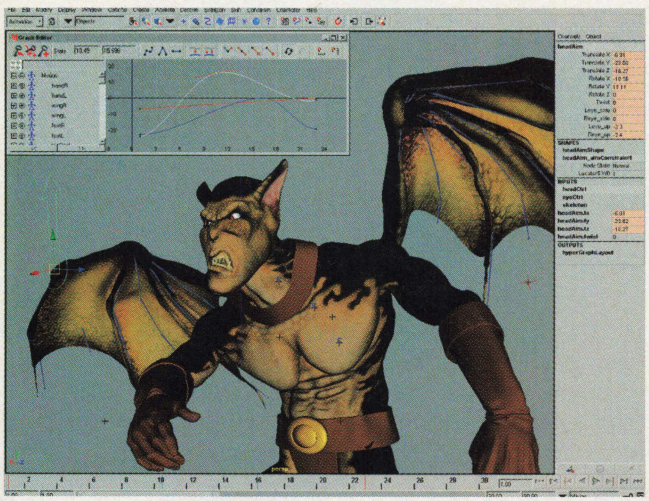


Real-Time Rendering Highlights Maya 2

An interactive photorealistic renderer heads up the new features of Alias|Wavefront's Maya 2, the latest version of the company's popular 3D animation and visual effects program. The renderer, called Maya IPR, allows real-time editing of lighting, textures, shaders, lens, and glow effects. With this capability, the company aims to provide visual effects artists and animators the speed of online video editing in a 3D rendering environment.

Other advances in Maya 2 include new deformer types and automated skinning capabilities, which should help simplify the creation and control of complex characters; textured particle emission and geometry duplication on particles; improved modeling tools for controlling curve and surface geometry; and a consolidated user interface that should reduce learning time for users.



Nick Ericson of Nick Ericson Studios, a New York-based special effects house, used an early version of Maya 2 to help create a television commercial featuring Planters' cheese ball product. "Each ball, and there were 40 of them, had about five shaders each—for the spice, the dust, and so forth," says Ericson. The texturing capabilities of the new program "probably saved us two days of work on those cheese balls."

Maya 2 ships in two configurations, Maya Complete 2, for game developers and artists; and Maya Unlimited 2, for professional animators and modelers. In addition to the features listed above, Maya Unlimited 2 includes subdivision surface technology, Maya Cloth, Maya Live (a matchmoving program), and Maya Fur.

The programs are available for both SGI Irix and Microsoft Windows NT workstations. The price of Maya Complete 2 is $7500; Maya Unlimited 2 is $16,000. The product is scheduled to ship in early summer.

—JD

(Toronto; 800-447-2542; www.aw.sgi.com)

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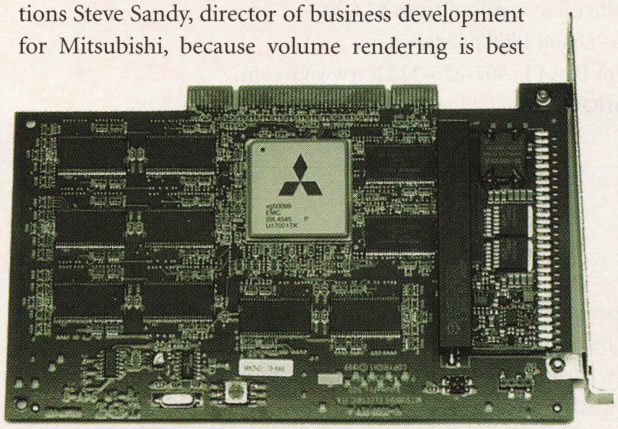
Plug-in Volume Rendering

Real-time volume rendering is now available on a card. The VolumePro 500, the first commercial product from Real Time Visualization (RT Viz), a newly created division of Mitsubishi Electronics America, incorporates what the company asserts is the first-ever single-chip approach to 3D volume rendering. The VolumePro architecture employs a raycasting algorithm that shoots the rays through a volume object from each pixel in an image. It tri-linearly interpolates samples along each ray, providing complex shading calculations and color assignments at the sample points. In addition to having its own gradients and shading, the VolumePro 500 can render a 256^3 dataset at 30 frames per second and is configured with 128MB of volume memory.

The $2995 PCI graphics card, which is being marketed on an OEM basis, will be available to vendors of workstations running Windows NT or Solaris/Unix. Due to the size of the onboard fan, the card must occupy either two slots, or an end-position slot.

The VolumePro is not an all-purpose board, cautions Steve Sandy, director of business development for Mitsubishi, because volume rendering is best



suited for irregular surfaces and interiors. The medical community, "among them scanner manufacturers and software developers," represents the largest potential user base for the product. Other VolumePro applications are seismic and mineralogic studies, aerodynamics and flow visualization, and industrial applications such as luggage inspection and non-destructive testing during manufacturing. "We are also working with several animation houses," says Sandy. "because voxels [volume pixels] are useful for creating amorphous effects such as water, clouds, dust, and fire."

An SDK will also be available in addition to the board, at a price of $2500. The VolumePro 500 is scheduled to ship in July.

—*JD*

(Concord, MA; 888-467-8849; www.rtviz.com)

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Game Developers Create OpenGL Standard

In an effort to avoid software driver conflicts and improve the performance of 3D hardware accelerated games on the Microsoft Windows platform, a group of game developers has created GLSetup. The developers intend for the program, now in beta, to be included on game CD-ROMs and to run as part of a game's installation, at which point GLSetup will detect a user's 3D hardware and automatically install the appropriate OpenGL drivers. The program is currently running alongside tests for Quake3's *Arena* game.

LightWork Introduces 3D Products for Developers

LightWork Design (Walnut Creek, CA) has launched Kazoo, an interactive 3D technology for applications developers. With Kazoo-enabled programs, end users will be able to work with 3D models and create images in a range of styles such as pen and ink, watercolor, and charcoal. The Kazoo line includes a viewer, encoder, and toolkit. For more information, visit the Kazoo Web site at www.kazoo3d.com.

SDRC Establishes Aerospace Center

Mechanical design software developer SDRC has launched a facility dedicated to creating product development processes for the design, assembly, testing, and product simulation of commercial aircraft, defense systems, and satellites. The designated "Aerospace Center of Excellence" will employ more than 30 engineers, and will be located in SDRC's San Diego, California, facility.

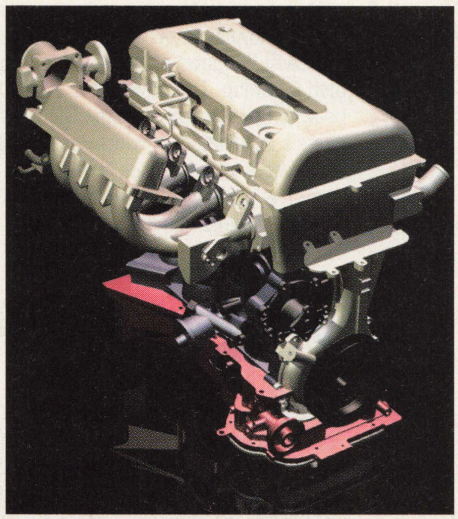
In Brief

LMS International (Leuven, Belgium) has acquired **CADSI** (Coralville, IA), which will become **LMS CADSI** and form the **LMS Mechanical Simulation Technologies Division,** a business unit focusing on virtual prototyping and design simulation... **Archway Systems** (Huntington Beach, CA) has assumed all rights to the VersaCAD product and trademark from **Parametric Technology Corp.** (Waltham, MA). As part of the agreement, Archway engineers will write a direct translator between VersaCAD and PTC's ProEngineer product... **Raindrop Geomagic** (Research Triangle Park, NC) announced that it will receive $5 million in venture funding from Franklin Street/Fairview Capital (Research Triangle Park, NC)... **Altair Engineering** and **Altair Computing** (Troy, MI) have jointly announced a merger agreement... Real-time 3D physics software vendor **MathEngine** (Oxford, England) has acquired **Lateral Logic** (Montreal)... Commercial imaging firm **Images.com** (New York) has acquired **Stock Illustration Source** (New York) and **Graphistock** (New York).

News is compiled and written by Computer Graphics World *Managing Editor Jenny Donelan.*

One-Stop CAD/CAM Shopping

One of the latest companies to throw its hat into the mid-range CAD ring is Varimetrix, with its new VX Vision product line. Actually, VX Vision is a collection of "hats." Billed as a full-service CAD/CAM product line, the Windows NT-based software offers a range of fully integrated 2D drawing and 3D surface- and solid-modeling capabilities as well as extensive computer-aided manufacturing features not available in most solid-modeling products.



VX Vision is built on a proprietary engine, the second generation of Varimetrix's Unified Parametric Geometry Kernel (UPG2), in an object-oriented environment. This architecture enables such modeling features as variable-offset shelling, volume and face offsets, surface creation from point clouds, surface matching and merging, and topology checking and healing. An advanced ray-trace renderer can generate photo-realistic views of the models.

VX Vision's CAM modules provide numerous techniques for calculating tool motion, including basic drilling and turning, multi-axis milling, and tilt-wire EDM. With 3D workpiece modeling, the system can simulate material removal and use this information to machine the remaining stock. An important feature is the software's ability to maintain complete associativity with the 3D product model. This lets users update manufacturing information directly from the design data, streamlining process definition and NC programming.

VX Vision supports efficient assembly modeling and management. An example is the software's data-loading paradigm. Unless an object is activated for edit, the UPG2 Object Manager loads only the display data for an object into memory—minimizing the memory footprint while maximizing the size of the assembly to work with.

Sketching and 2D drafting tools round out VX Vision. With its Quick Draw function, a single intelligent command generates all of an assembly's common sketch geometry. As objects are created, they can be automatically dimensioned and constrained. Additionally, users can reference geometry and dimensions to create associative links between features and parts. For 2D drafting, Quick Draw and Quick Dimension tools expedite standard geometry creation and annotation. The product line is priced from $4,000.

—Diana Phillips Mahoney

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infoNOW 128

Flat Images Grow Up

Web content creators and graphic artists can make 2D images spring to 3D life with Canoma 1.0. The new product from MetaCreations works with any digital source, such as photographs or scanned-in paintings or sketches. To convert an image to 3D, the user creates a 3D wireframe over it. A single image can be used, though multiple images produce better results, according to the company. Canoma then automatically generates the required geometry and photorealistic textures, creating a 3D image that can be rotated, walked through, and animated. The file can be altered in an image-editing package, then brought back into Canoma, where the changes are instantly incorporated.

Canoma models can be exported to other 3D packages such as Bryce, Ray Dream Studio, or 3D Studio Max. Other supported file formats include OBJ, DXF, SCN, and VRML2. Animations can be exported as frames or QuickTime movies. In addition, the model can be posted on the Web as a MetaStream object.

According to MetaCreations, Canoma is best for modeling man-made structures and environments, such as packages, furniture, and buildings. It is less suited for modeling irregular, organic shapes such as people and trees. The manufacturer envisions Canoma as a tool for E-commerce and other related applications.

Canoma runs on Windows 95/98/NT machines or Power Macintoshes. The cost is $499, or $469 as a download from the company's Web site.

—JD

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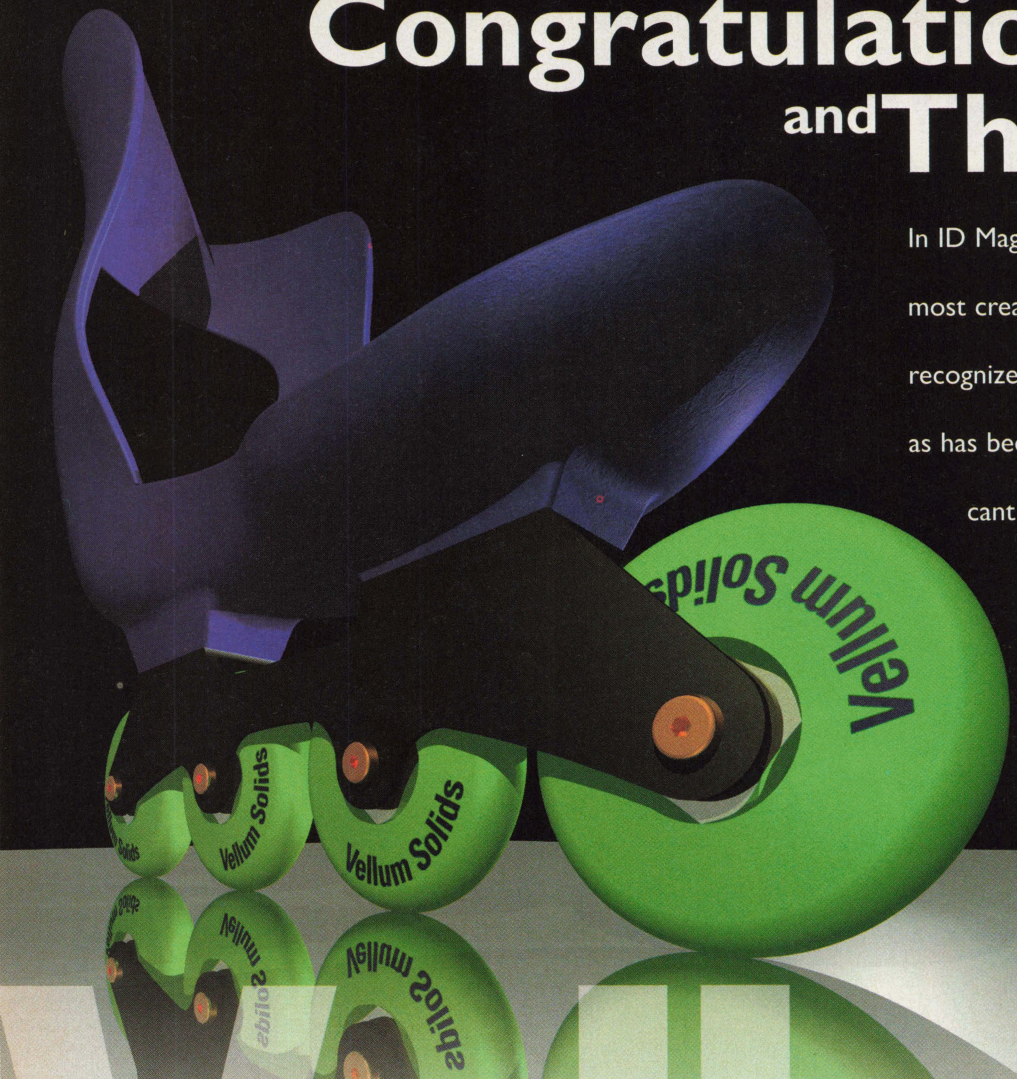

In ID Magazine, the efforts of many of the most creative and influential designers are recognized for their recent work. This year, as has been the case for many years, a significant number of those receiving awards listed Vellum among the tools used to create their designs. We are proud to be associated with such a talented group of designers.

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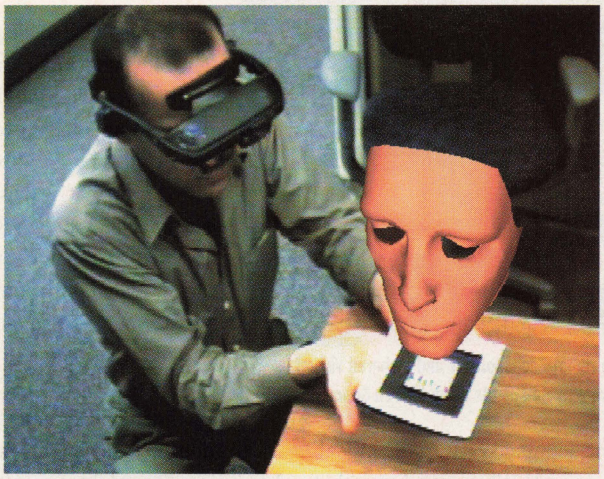
A New Kind of "Get Together"

Over the past few years, there's been a proliferation of digital tools aimed at facilitating or enhancing collaboration among multiple parties in applications ranging from architectural and engineering design to medical consultation to gaming. Some of the more recent examples include tools that enable users to share 3D models over a network and the development of fully immersive virtual worlds in which multiple users can view and manipulate 3D information. While innovative and useful, these techniques tend to replace, rather than complement, existing modes of collaboration, and thus can be harder to incorporate into standard practice. A project by researchers at the Human Interface Technology (HIT) Lab at the University of Washington seeks to provide a more intuitive method for using digital technology to support collaboration.

Called Shared Space, the project is based on augmented reality, a technology through which real and digital views are combined into a single display. Using see-through headmounted displays (HMDs), users see stereo 3D virtual images overlaid onto real-world objects. In a face-to-face collaborative setting, users can see each other and the virtual images between them, and are able to communicate naturally as they manipulate the virtual objects. According to project director Mark Billinghurst, the group looked to an augmented-reality paradigm in order to compensate for some of the deficiencies of existing desktop-collaborative software programs and virtual-reality approaches. "A lot of the current software forces people to use a monitor-based interface, in which you show 3D models on a 2D screen—which isn't at all natural. And in the case of immersive virtual environments, people are separated from the real world and their normal tools. You couldn't have architects talking about 3D models in an immersive 3D environment and also making notes on paper or referring to real plans." With Shared Space, users see 3D models in 3D, and they can interact with the data while maintaining their real-world connections.

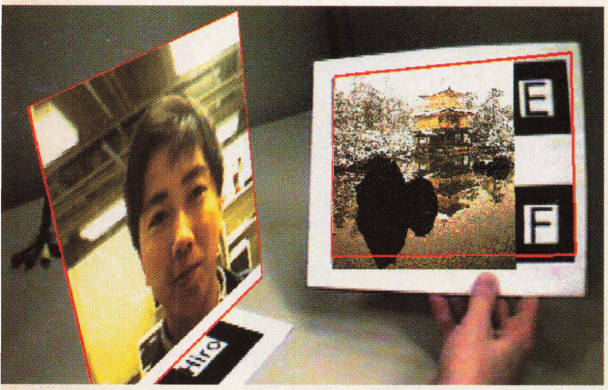


Wearing a camera-equipped, see-through HMD, a Shared Space user can see both his collaborators and the virtual objects between them. The virtual objects are only visible to those wearing the HMDs (below).

Precise Registration

Shared Space uses computer-vision techniques to overcome one of the biggest obstacles to effective augmented reality: precise image registration. For example, in a demonstration of the technology's application in the area of urban design, collaborators wearing the see-through HMDs surround a table laden with small white blocks. On each block is a square mark embedded with a pattern. Small video cameras mounted on the HMDs record the blocks, and image-processing software is employed to find the squares. The software, developed in collaboration with Dr. Hirokazu Kato of Hiroshima City University in Japan, calculates the position and orientation of the camera relative to the square, and looks for the patterns in the square. The system then identifies the patterns, which represent specific virtual buildings, and projects the relative virtual building onto the block. "Prior to running the application, we train our software to recognize the patterns. When the image-processing code finds a pattern that it 'knows,' it associates the block with the unique virtual image assigned to it," says Billinghurst.

Because the system continuously calculates the position and orientation of the camera, the images appear to stay exactly registered to their assigned blocks as the users move the blocks around. Consequently, users are able to interact with the model in an intuitive manner. They're able to change the model dynamically and swap textures in and out. "To cause interactions between the models, we can have physical blocks that



Virtual video of a remote collaborator and a shared virtual image are attached to real-world objects using Shared Space.

represent some action, like 'swap the model' or 'delete the model.' When you bring that block next to another block, the camera recognizes it and causes the action to happen," says Billinghurst. In addition, different types of information, such as wiring diagrams and building floor plans, can be incorporated into the display. Currently, the researchers are running Shared Space on Silicon Graphics 0_2 computers. The team is also experimenting with the new SGI NT machines. Their goal is to port the code to Windows NT.

Because Shared Space is application-independent, it can be used in nearly any application that could benefit from an image overlay onto the real world. The software supports the VRML2 format, so users can easily adapt their existing VRML2 applications to it. Though the researchers are currently demonstrating the technology using see-through HMDs, the output can also be viewed on any display that takes an NTSC input and has a standard video camera attached to it.

In addition to facilitating face-to-face collaboration, Shared Space can also be used as a teleconferencing interface for remote collaboration. Instead of overlaying a virtual object onto a block, users can overlay live virtual video of a remote person. "Potentially, we can overlay multiple videos onto multiple blocks," says Billinghurst. "In theory, when you want to conference someone, you could pull out a piece of cardboard with that person's name on it, establish the connection with the remote computer and the remote person, and the system will stream live video onto that block. You can spread multiple images around in the real world to create a virtual conference space."

The HIT Lab team will demonstrate the Shared Space technology at this year's SIGGRAPH conference in Los Angeles in August. There, they will be giving away the image-tracking and registration libraries they've developed in order to help others working in the field of augmented reality streamline their application-development process. "Typically, people developing augmented-reality applications have to spend a lot of time developing the tracking and registration code," says Billinghurst. "By giving this code away for free, we hope that people will be able to explore all sorts of possibilities and develop hundreds of interesting applications."

More information can be obtained from the project Web page (www.hitl.washington.edu/ research/shared_space).

Diana Phillips Mahoney is chief technology editor of Computer Graphics World.

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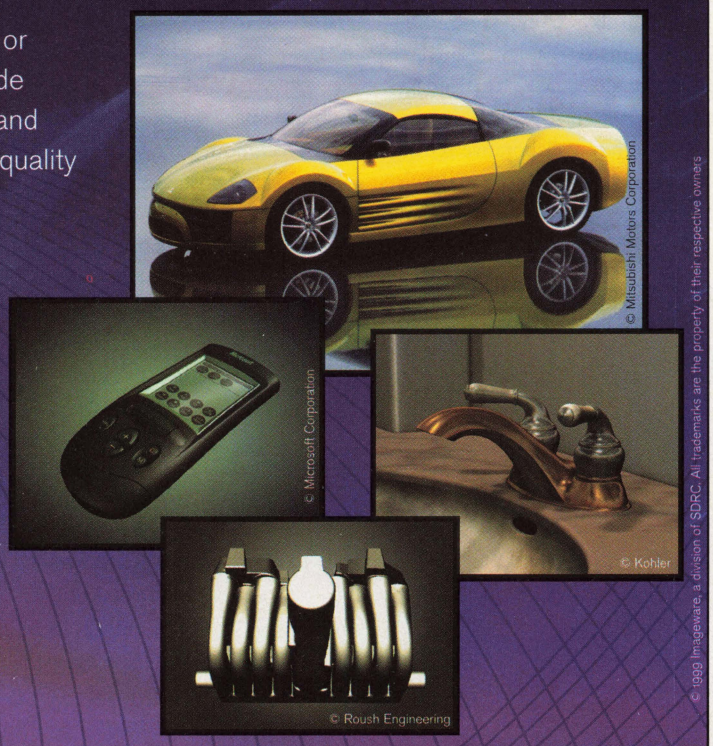

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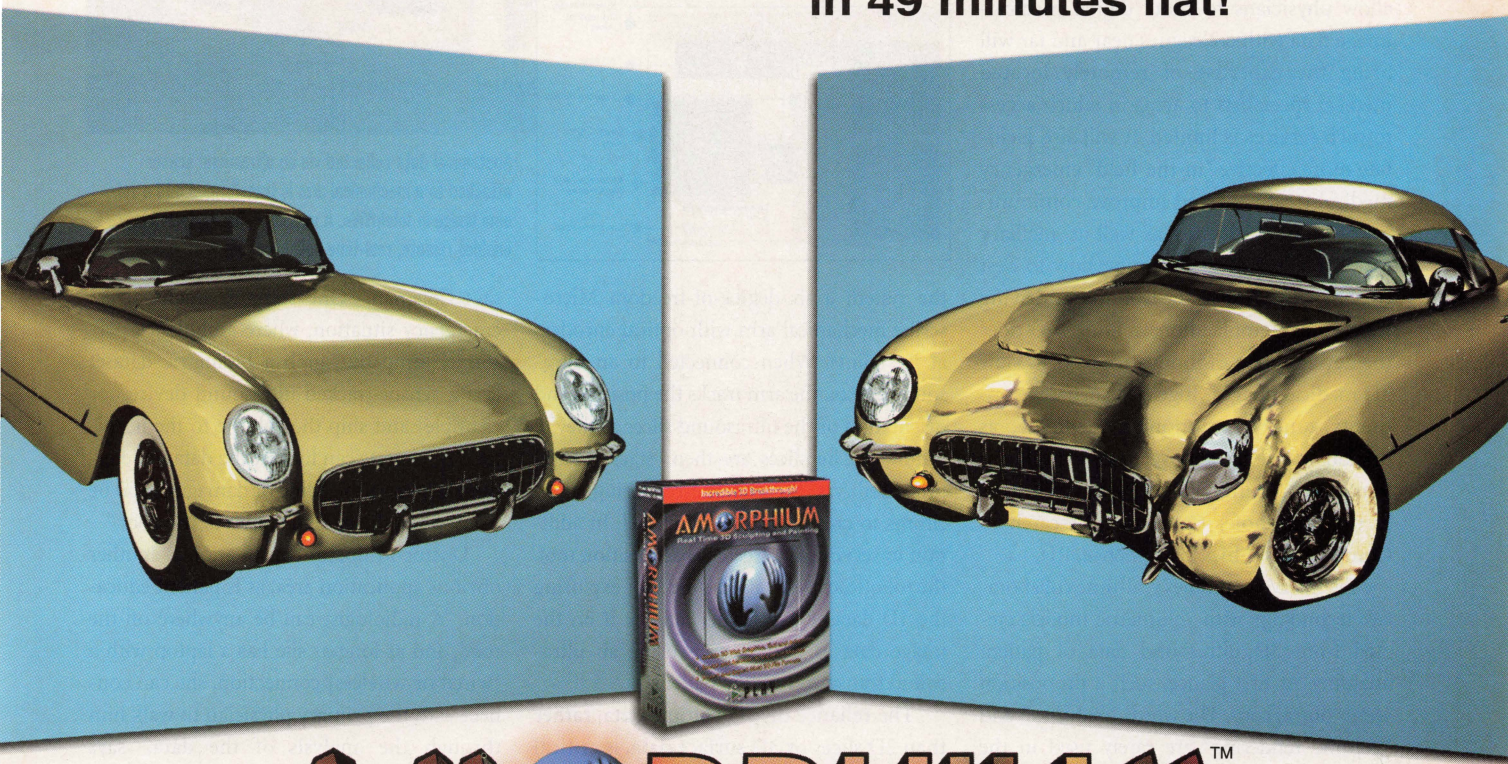

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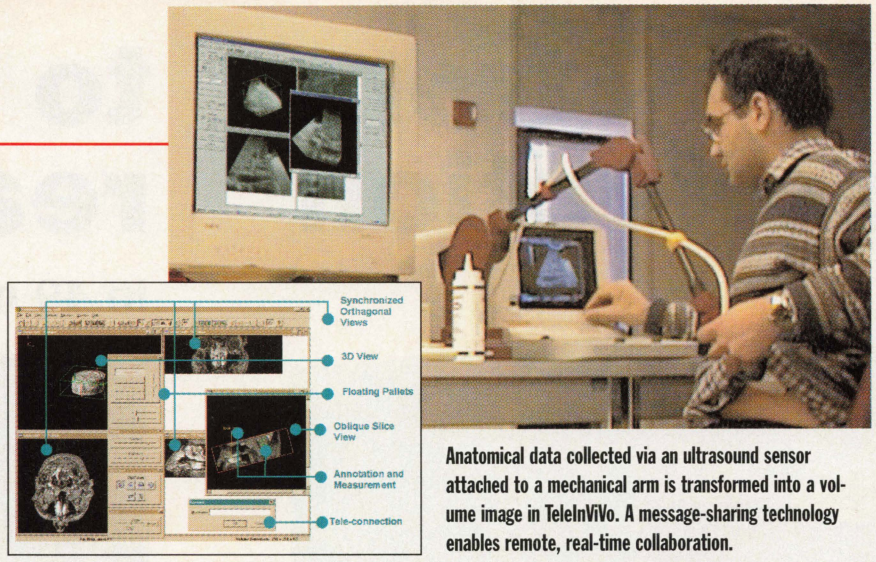


Anatomical data collected via an ultrasound sensor attached to a mechanical arm is transformed into a volume image in TeleInViVo. A message-sharing technology enables remote, real-time collaboration.

The advent of telemedicine is poised to change the face of health care. Network-based collaborative tools that allow physicians to share digital medical-image data with colleagues near and far will bring the expertise of remotely located medical specialists to areas in which access to such services is limited. It will also facilitate more effective "in-the-field" emergency medical treatment and improve communications among doctors as well as ancillary care providers in determining how to best treat patients. And as the technology driving telemedicine applications matures, so does the development of innovative ways to view 3D medical images. Together, such developments could revolutionize medicine, as demonstrated by a novel telemedical system, called TeleInViVo, created by scientists at the Fraunhofer Center for Research in Computer Graphics (Providence, RI).

TeleInViVo combines real-time collaborative technology with volumetric models created from 3D ultrasound data of patient anatomy. At first glance, such a proposition seems outrageous. The words "real-time" and "volume rendering" are rarely used in the same sentence, unless of course the words "no can do" are in there too. This is because volumetric datasets are huge and typically stress the processing capabilities of the host workstation. The thought of trying to move that much data across a network is unsettling.

To overcome the technical obstacles, the Fraunhofer researchers utilize custom volume-visualization algorithms to turn 2D image slices into an accurate 3D volumetric dataset in conjunction with a unique message-passing paradigm to drive the system. "There are two separate copies of the [volume model] running on separate computers that connect over any TCP/IP network. The two systems update their states based on [interaction] messages," says project leader John Coleman. "System one says, 'I'm on slice 53, and I'm slicing through the volume at a 20 degree angle,' then that information is relayed to the other system and it sets its interface to be the same, in real time." Thus, the volume itself is not being sent back and forth.

The researchers have also integrated into the system a six-degree-of-freedom Microscribe mechanical arm with optical encoders at the joints. When connected to an ultrasound sensor, the arm tracks the position and orientation of the ultrasound slices as they're acquired. The slices are then "stacked" and processed via the volume-rendering algorithms to create the volume model. In addition to serving as a freehand acquisition tool, the robotic arm can also be used for exploring the 3D dataset. Physicians can use it on the image data as if they were using an ultrasound transducer on the patient.

The reliance on 3D volume data, rather than 2D slices or 3D surface data, is critical to the TeleInVivo system. "The 3D view allows you to understand some of the spatial relationships. You can rotate the volume and look at it from different angles. And [the system] allows you to re-slice the volume from any arbitrary angle. You're not limited to the angle that you originally got your data in," says Coleman. The software also incorporates tools for analyses, measurements, annotation, and segmentation.

Real-World Uses

TeleInVivo was initially developed for the US Army with funding from the government's Defense Advanced Research Projects Agency (DARPA) to support medical operations in Bosnia . "In the Bosnia project, we were going over satellite connections as low as 9600 baud, and doing real-time interactive consultation," says Coleman. The system developed for the Bosnia trial was Unix-based. The current version is running on Microsoft Windows NT.

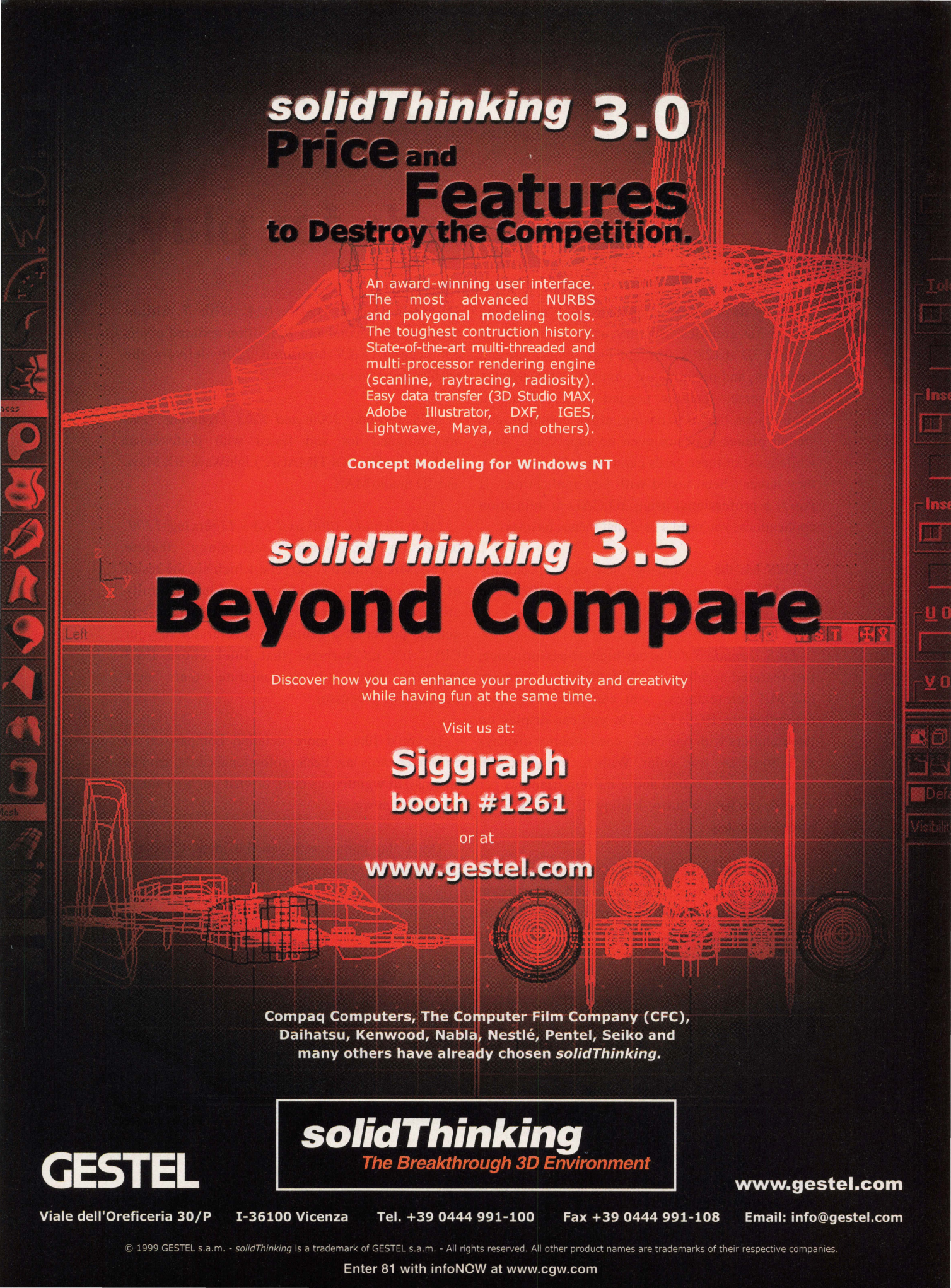
The technology's potential is limitless, says Coleman. "One scenario might be an emergency situation, where ambulance personnel jump out, grab a biometric dataset [via a sensor-tracked ultrasound device, for example] and ship the volume to the hospital. The experts can look at the data to determine where the bleeding or damage is, and be ready when the patient comes in the door."

Doctor-to-doctor consultation is another obvious application area, as is patient education. "A radiologist can be anywhere on the road, and as long as she has a laptop with a [wired or wireless] connection, she can connect with the primary physician to walk him through the analysis of the data," says Coleman. Similarly, a physician can use the system to help a patient understand the details of a particular procedure. "The patient can be remotely located, with a version of the software running on her computer."

TeleInViVo is not limited to the sharing of ultrasound imagery, nor is it limited to medical applications. "It can be applied to any kind of 3D dataset, such as CT, MRI, or PET images. And though our emphasis right now is on medical applications, it can be used in essentially any application relying on volumetric data," says Coleman. Two non-medical applications the researchers are pursuing are non-destructive testing and structural evaluation and inspection.

Currently, TeleInViVo is limited to point-to-point collaboration, but the next iteration will enable multipoint collaboration, allowing large groups to view and share the same image.

Diana Phillips Mahoney is chief technology editor of Computer Graphics World.



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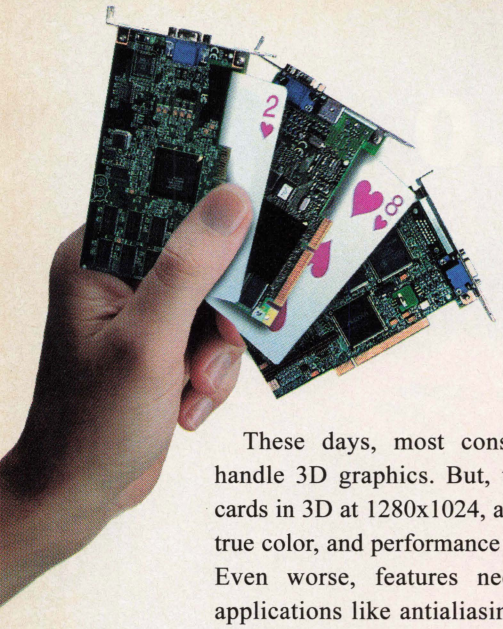

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These days, most consumer-level cards can handle 3D graphics. But, try using one of those cards in 3D at 1280x1024, at a high refresh rate and true color, and performance plummets dramatically. Even worse, features needed for professional applications like antialiasing, alpha blending, and stencil planes may not even be supported. And, while most of these cards claim OpenGL readiness, they haven't been tested with key applications. If you're a professional using 3D CAD or animation applications, you need a card that means business.

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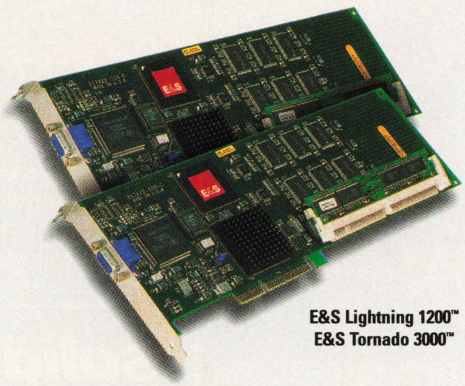

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CAE: Risks vs. Rewards

Conventional wisdom says that more is better when it comes to using CAE tools for product design. Indeed, conducting CAE studies early in the design cycle can certainly help eliminate poor design ideas before they are carried out, thus avoiding costly prototype builds, extensive testing, undue failure analysis, and numerous redesign efforts downstream.

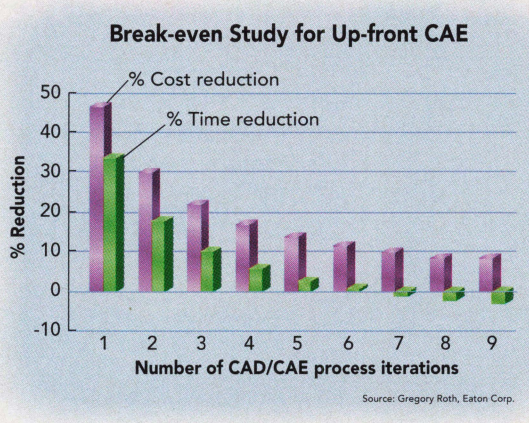
But there is a dark side. If the CAE process is not implemented fully and carefully in this part of the product development cycle, it can generate more problems than it solves. Performing study after incomplete study will quickly take a project beyond deadline and into the red.

To make CAE analysis pay requires a full commitment—one that will not bypass some aspect of relevant analysis in the interest of time. If a given component must meet both thermal and structural performance criteria, for example, then bypassing thermal analysis in favor of only structural analysis could end up draining more resources than the traditional design process. If the part goes on to fail a thermal test downstream, the whole analysis will have to be repeated, due to changes made to meet the thermal parameters of the design.

Design engineers must avoid the temptation to conduct incomplete CAE studies

This is not to suggest that every possible technical study of a system or product should be conducted or is warranted. Some aspects may not require evaluation. For example, one would not conduct magnetic flux analysis on a ballpoint pen if no relevant performance risk had been identified. But if there were such a risk, then a full study should be completed.

Design engineers may be tempted to conduct incomplete studies for several reasons. Chief among these is a perception that there isn't enough time or trained staff to fully use CAE early in the design process. Most traditional CAD/CAE engineering paradigms are not structured to support such up-front analysis. Historically, the success of most early-stage design activities is measured by getting a drawing out the door, not by achieving a functional design. CAD managers may become nervous over this apparent delay. And certainly, the additional time used during an up-front virtual prove-out appears to be slowing down the process. Of course, what the managers fail to see is that the benefits will appear downstream, when further design iterations, testing, and gray hairs are no longer required.



Assuming that using CAE early in the design process eliminates at least one design cycle as compared to traditional design processes, the break-even point for reducing design time is six iterations.

But there are limits to the efficiency of using CAE early in the design cycle, because it does add some costs and time compared with traditional processes. Thus, when up-front CAE is incorrectly implemented, causing the CAE/CAD based process to be repeated because a design failure was not caught during the initial phase, the savings that should have achieved in preventing downstream design iterations is negated by the burdens of the up-front analysis.

I recently compared the costs and time associated with performing CAE up-front with those of more traditional studies. One study involved a scenario in which the CAE studies missed a failure mode, and empirical tests caught it, thus requiring a redesign iteration. How would that affect the efficiency of the process? It is assumed for purposes of this study, that no matter how many design iterations are required using CAE, the technique will always prevent at least one iteration compared to the traditional design process. "Break-even Study for Up-front CAE" (above) shows that under this assumption, the break-even point for iterations is six, at which point you're spending more time that you would have had you used traditional procedures. The implication is clear: The benefits decline as the number of iterations increases.

What all this means is that using CAE early in the process can achieve significant efficiencies, if you are careful to fully implement the CAE capabilities and not bypass any aspect of them. Doing so can diminish any potential returns and wind up costing more money and time than a traditional approach would have. The goal of using CAE up-front is to fully qualify the performance of the products and get it right the first time.

BY GREGORY ROTH

Gregory Roth is a senior engineering specialist in the Virtual Prototype Department at Eaton Corp.'s Innovation Center in Southfield, Michigan.

"We needed to find a way of dealing with the huge computing loads that serious ray tracing presents..."

The Super Bowl is the single biggest event in broadcast television, with up to 800 million viewers worldwide. This year, Fox Sports was looking for someone to produce a visually stunning animated opening sequence for "*Super Bowl XXXIII on Fox*". They turned once again to Digital Dimension, a North Hollywood-based studio specializing in 3D animations, motion graphics, and visual fx.

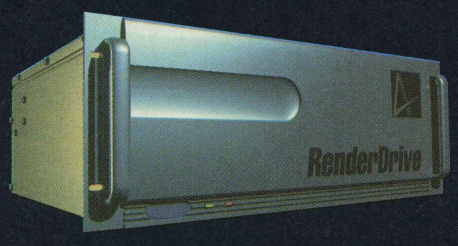
Digital Dimension faced a number of challenges. First of all, the project needed to be completed rapidly. With a short time to complete the job, and lots of creative interaction with Fox expected, speed was of the essence. Secondly, while much of the sequence could be done using conventional tools and methods, the inclusion of large stretches of water and a gigantic replica of the Vince Lombardi Trophy meant that they would have to be ray traced in order to achieve the level of photorealism required.

Normally, installing the rendering resources on the scale required by a project of this complexity would have been a difficult, expensive, and time consuming process. But thanks to RenderDrive's revolutionary rendering technology, it proved quick and trouble free.

Fox Sports loved the finished results, and Digital Dimension's animators loved the quality and power of the RenderDrive. In fact, they may need to break out their dress shoes again for this year's Emmy awards ceremony.

"We could not have done this project in the time allotted and to the quality standard that Fox requires without the power, speed and increased interactivity that RenderDrive gave us."

Ben Girard
General Manager, Digital Dimension



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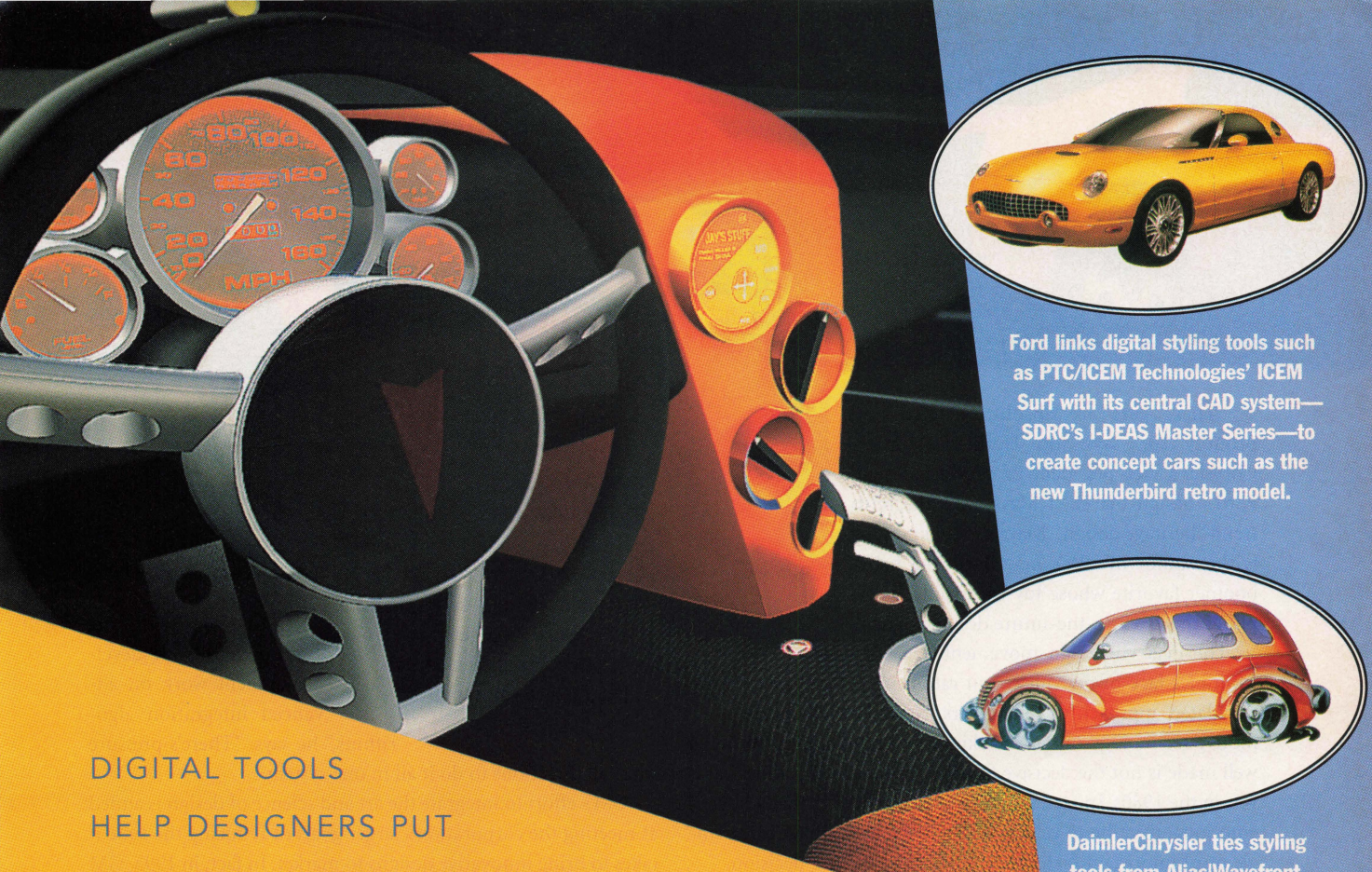


Ford links digital styling tools such as PTC/ICEM Technologies' ICEM Surf with its central CAD system—SDRC's I-DEAS Master Series—to create concept cars such as the new Thunderbird retro model.

DaimlerChrysler ties styling tools from Alias|Wavefront and others to its core Catia software from IBM/Dassault to model concepts such as the new retro PT Cruiser.

DIGITAL TOOLS HELP DESIGNERS PUT MOTION AND EMOTION INTO DETROIT'S NEW "RETRO" CAR MODELS

back to the future

BY JEFFREY ROWE AND STEVEN ASHLEY

The future of automotive styling is its past. Indeed, roaming through this year's Detroit and New York auto shows was a bit like taking a stylistic stroll down memory lane. Ford's new Thunderbird show car sported vintage porthole windows and smooth lines that evoke the 1955 T-bird classic. General Motors featured a '55 Chevy Nomad wagon updated for the next century and a new Chevrolet Impala flashing its familiar phalanx of round tail lamps. Sixties "muscle" cars reappeared in the brawny forms of Pontiac's GTO design study and the Dodge Charger R/T concept car. And Chrysler's new hot-rod minivan—the street-smart PT Cruiser—elicited nostalgic gawks from old-timers and mondo coolness points from kids unfamiliar with the car's fresh, "bad boy" look. In the car business these days, everything old is new once more.

GM uses Alias and Unigraphics tools for designs such as this new-old Chevy Nomad.

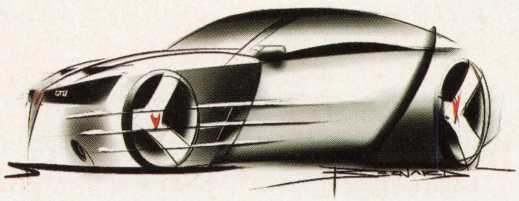
GM designer Jay Bernard used Studio Paint and Auto Studio from Alias|Wavefront to build the new Pontiac GTO concept car around an engineering model created with Unigraphics software.

"These cars are absolutely retro and proudly so," says Jon Herlitz, Daimler-Chrysler's vice president of product design. Ford's design maven, J Mays, calls the retro trend "heritage design." Mays should know, he is the author of VW's new Beetle—a baby-boomer favorite whose toy-car profile exemplifies this back-to-the-future design vogue.

The déjà vu design movement has not arisen from of a lack of new ideas, but rather is a carefully calculated approach to selling cars. Nowadays the automotive technology under the skin is better than ever, so being well made is not the decisive factor in purchase decisions that it was in the 1980s. In fact, market research indicates that a buyer's emotional reaction to vehicle styling and brand image is the single most important factor driving a final purchase decision.

It's no surprise, then, that after two decades of generally bland design (brought on by the energy crisis, which led to the aerodynamic, fuel-efficient "jellybean" look of the Ford Taurus), car makers have refocused on styling. "Consumers want vehicles that look unique and new," says Bryan Nesbitt, exterior designer of the PT Cruiser. Yet despite their preference for novelty, they are also attracted to cars "that are familiar, not foreign, in style."

It's also no surprise that today's automotive stylists are turning to digital styling tools to satisfy the demands of retro car design—arguably their biggest challenge to date—to blend the old with the new, meld the art with the science, and inject both motion and emotion into their new car models.



Bernard's Studio Paint sketch best captured the GTO design intent.

Blending Art and Science

As any car designer will tell you, it is the integration of the aesthetic and the technical that is the secret to a truly superior car design. And both car makers and CAD vendors alike point out that integrating digital styling tools into company-wide central CAD/CAM/CAE systems is the key to success in creating the latest car styles. For example, at GM, where Unigraphics Solutions software is the core CAD system, the trend is toward "tighter integration with Alias|Wavefront [styling software]," according to Thomas Pritchard, strategic program manager for Unigraphics Solutions in Livonia, Mich. "GM takes a big role in pushing both sides together with its own software-development work on advanced integration algorithms," he says. "There's pressure from all directions to do it all in one system."

GM's effort to integrate the art and science of design is aimed at meeting the corporation's larger goals of reducing the time it takes to bring innovative designs to market. In fact, in 1995, GM launched its Synchronous Math-Based Process effort to integrate all of its CAD/CAM/CAE tools into one common core system—Unigraphics. Since then, GM has expedited vehicle development, introducing an average of one new product every 28 days, while reducing development cycles from 37 months three years ago to 24 months or less today.

At Ford, where SDRC's I-DEAS Master Series serves as the central CAD system, ICEM Surf has been a part of the company's automotive-development program since 1991, and is reportedly still being used among other tools in the development of Ford's new vehicle programs. Ford says it aims to integrate best-of-breed styling and CAD tools to help meet the goals of its C3P program, which, like GM's strategy, is geared toward improving aesthetics and quality while reducing time to market. In fact, virtually all major car makers, foreign and domestic, are taking similar tacks, including Daimler-Chrysler, which is linking its core CAD program—Catia, from Dassault Systemes—to digital design tools from Alias|Wavefront as well as a variety of other digital styling software vendors. (See sidebar, "Digital Tools for Automotive Styling," page 27.)

Reinventing the GTO

Because car-design processes vary widely among manufacturers, and because the details of the digital tools and methodologies are kept proprietary, giving specifics about which conceptual styling programs were used for these retro car designs and how

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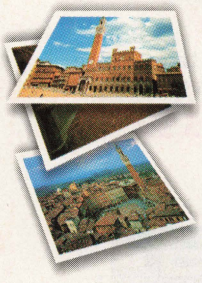

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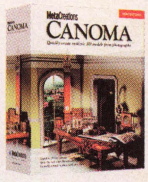

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DIGITAL TOOLS FOR AUTOMOTIVE STYLING

While it's no secret which CAD/CAM/CAE suites the "Big Three" U.S. auto makers employ (DaimlerChrysler uses IBM/Dassault Systemes' Catia, Ford uses SDRC's I-DEAS Master Series, and GM uses Unigraphics Solutions software), these same companies are highly secretive about the digital styling tools their designers use. This list describes some of the digital tools used for automotive styling in Detroit and around the world:

ALIAS|WAVEFRONT
(a subsidiary of SGI)
Toronto, Ontario
www.aw.sgi.com
infoNOW 132

AutoStudio Version 9, created specifically for automotive styling, is a NURBS-based surface modeler with tools that can maintain positional, tangent plane, or curvature continuity between surfaces.

Surface Studio 9 has surface-modeling and reverse-engineering tools, real-time diagnostics, and scan data processing technology. Its suite of tools creates surface models for integration with engineering and manufacturing processes.

AUTO•DES•SYS INC.
Columbus, OH
www.formz.com
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formZ is a 3D "form synthesizer" that dynamically generates 3D solids and 2D shapes that can be extruded in a direction perpendicular to their plane or a point. Derivative objects can be generated from other objects, including 2D shapes, sweeps along arbitrary paths, 2D and 3D sections, projections of objects including unfolded objects, and parallel objects.

IMAGEWARE
(a division of SDRC)
Ann Arbor, MI
www.iware.com
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Surfacer is a reverse-engineering tool for creating free-form surface models from physical sculptures or concept prototypes. Its surface-modification and analysis tools provide a smooth continuous surface.

IBM/DASSAULT SYSTEMES
Burbank, CA
www.dsweb.com
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FreeStyle Shaper for creating styled shapes and surfaces has interactive shape-deformation functions for intuitively matching, smoothing, and trimming curves and surfaces. Quality checking is provided with extensive curve- and surface-dynamic diagnosis. Because the system offers a math-free representation, designers can manipulate the bodies and associatively reproduce surface changes on other geometries.

FreeStyle Optimizer extends shape- and surface-modeling functions to morphing complex, multi-surface shapes. A designer can globally change multiple surfaces as if they were a single patch while preserving the design characteristics.

ICEM TECHNOLOGIES
(a subsidiary of PTC)
Arden Hills, MN
www.ptc.com/icem
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ICEM Surf supports direct modeling techniques that optimize the update cycles in design and engineering. Since surfaces are directly manipulated, there is no need to define and redefine curves and constantly re-skin modified curves to develop the surfaces. With simultaneous real-time analysis, the reflection lines, curvature, or deviation from reference surfaces can be monitored dynamically.

Conceptual Design and Rendering System (CDRS) allows curves to be developed freehand or generated by tracing directly from scanned images. Any and all points on a curve can be modified and blended together equally, or one shape can dominate another. Models can be dynamically sculpted by pushing or pulling on curves and observing how connected surfaces update.

MATRA DATAVISION
(a partner of Dassault)
Andover, MA
978-685-5511
www.matra-datavision.com
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Euclid Styler shapes sculptural parts, creates their outer skin, and makes a close coupling between outer skin and structural inner parts and sub-assemblies. For control of final curvature quality, designers can sweep light lines over surfaces or visualize cross-selection planes across an entire part, then cut defective patches from the model, correct them, and re-integrate the model surface.

ROBERT MCNEEL & ASSOCIATES
Seattle, WA
206-545-7000
www.rhino3d.com
infoNOW 138

Rhino can create, edit, analyze, and translate NURBS curves, surfaces, and solids. It has limited support for polygon meshes, but imposes no limits on complexity, degree, or size. It creates surfaces from 3 or 4 points, from 3 or 4 curves, from planar curves, etc., and edits surfaces from control points, handlebars, match, extend, merge, join, untrim, rebuild, shrink, and Boolean.

PARAMETRIC TECHNOLOGY CORP. (PTC)
Waltham, MA
www.ptc.com
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Pro/Desktop provides feature-based modeling, conceptual design, and drafting in an assembly-centric environment with no functional barriers between part and assembly design. It employs functional form features, not geometry, for creating features; placing multiple solid bodies in the same part and multiple profiles in the same sketch; adding relationships between sketches; and using and reusing features as components.

Pro/Engineer 2000i includes some 500 enhancements, notably Behavioral Modeler, which reduces the need for designers to iterate through multiple designs to achieve a required result by "automatically" solving design problems.

SDRC
Milford, OH
www.sdrc.com
infoNOW 140

I-DEAS Master Surfacing is the surface modeling complement to the NURBS-based I-DEAS Master Modeler and provides curve- and surface-creation tools for lofting, sweeping, and blending surfaces, for local and overall control of surface shape. Shapes can be created and changes made between relationships are "remembered" because geometry entities such as surface tangencies are maintained throughout the design cycle.

UNIGRAPHICS SOLUTIONS
Maryland Heights, MO
www.ugsolutions.com
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UG/Freeform Modeling can design complex freeform shapes, either directly on solid bodies, or as independent sheet bodies, which are similar to solid bodies except they do not have to enclose a volume. Sheet modeling is fully integrated with solid modeling and allows freeform shapes to be independently created and later applied to solid designs.

they were integrated with the central CAD system is difficult. But we were recently given a rare glimpse inside GM's Design Center in Warren, Michigan, and the opportunity to talk with the designers of GM's new retro models, including the Pontiac GTO concept car. Because of the unique retro-styling demands and engineering complexity, the process used by the Design Center to produce the GTO and other concept cars serves as an example of state-of-the art computer-aided automotive design—which itself is at the leading edge of industrial design (CAID). Perhaps as important, it offers insight into the integration of the art and science of automotive design, the merging of CAID and CAD.

Originally, GM's newest concept Pontiac GTO was never intended for public display. But it received such an overwhelming response internally that GM decided to let it out of the studio and see if the public would react the same way. Judging from the reception GM says the retro design received at the North American International Automotive Show in Detroit last January, the concept might someday become a reality.

Produced from 1964 to 1974, the Pontiac GTO—which stands for either "Grinds Tires Off" or GM's more official line "Gran Tourismo Omologato" (borrowed from a famous Ferrari racer)—epitomized the muscle-car era with its hood-mounted tachometer, disappearing headlights, distinctive paint striping, and horsepower to spare.

To fully capture the feel of the original model but give it a fresh look GM, the largest design organization in the world and user of more computer-aided technologies than either Industrial Light & Magic or Disney—originally assigned a dozen digital stylists to the project. But as with most projects, the team member with the best feel for the design was quickly identified and given leadership responsibility for the project, while most of the rest of the team members were assigned to other tasks. The actual GTO displayed publicly was largely the work of one pivotal creative person—Jay Bernard—and was produced in just a couple months.

A Ground-Breaking Process

As is customary for new projects at GM, the original GTO design team was given an engineering "package," a Unigraphics model containing the car's fixed specifications such as height, length, wheel base, engine size, and interior-space requirements. The stylists began by creating concept sketches in 2D using Studio Paint from Alias|Wavefront and overlaying them directly onto the engineering package. "Using Studio Paint is like drawing on tracing paper," says Bernard. "We can also create layers and place one on the front of the car, another on the back, or move them around wherever we like."

Glen Durmisevich, staff project designer, finds that the process is "just about as natural as using pencil and paper. We can capture the designer's intent and gestural quality, which gives character to any design."

After Bernard's sketch was chosen as the one that best captured both the spirit and the letter of the design intent, he built a 3D wireframe model and then added surfaces using Alias|Wavefront's Auto Studio, a program created expressly for 3D automotive modeling. "Auto Studio works in much the same way as Studio Paint in that it allows you to combine the sketches and the engineering data as you create 3D surfaces," Bernard says. He also used the program to create a 3D animation that shows how the car would appear to someone approaching the vehicle, opening the door, getting in, and looking and moving around. He believes this was far more effective than static images would have been for giving a sense of the look and feel of the car, particularly the interior.

The 3D interior and exterior GTO design concepts were reviewed using VisualEyes, an internal 3D virtual reality (VR) application that is used on most GM design concepts to stereo-

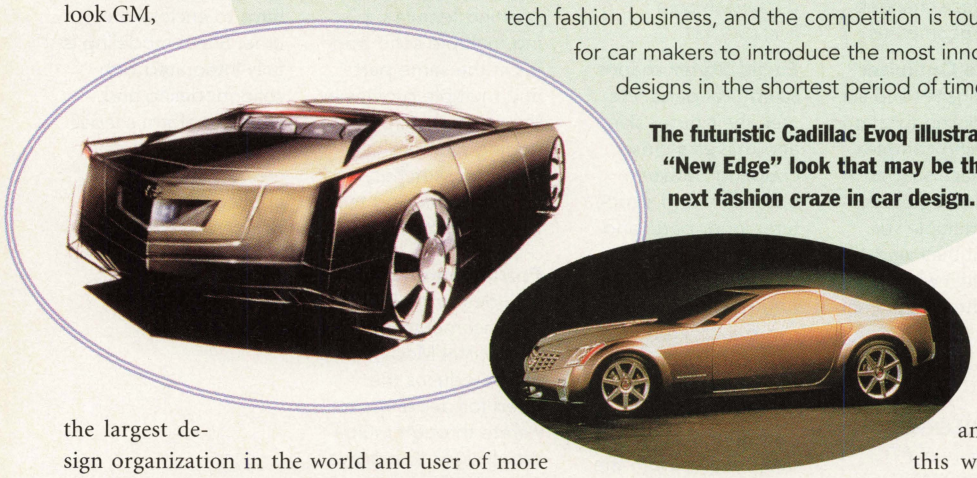
High-Tech Fashions

The retro trend may seem innovative to most consumers, but in some designer circles it is already becoming passé. As some stylists see it now, the next wave of cars will have tailored, crisp lines like those of a structured Hugo Boss men's business suit, not the curvy, unstructured lines of, say, a loosely draped Armani.

Ford has dubbed this new aesthetic "New Edge," and points to its Mercury Cougar concept car as an illustration of prominent surface creases and "hard" intersections between planes—a look that aims for hard-edged sophistication without being boxy.

The futuristic look was also represented at this year's auto shows by the new Cadillac Evoq, which was created with digital sketching tools and converted into 3D surfaces by virtual sculptors and modelers at GM's Design Center in Warren, Michigan.

What all this highlights is the fact that the car industry has become the ultimate high-tech fashion business, and the competition is tougher than ever for car makers to introduce the most innovative designs in the shortest period of time.



The futuristic Cadillac Evoq illustrates the "New Edge" look that may be the next fashion craze in car design.

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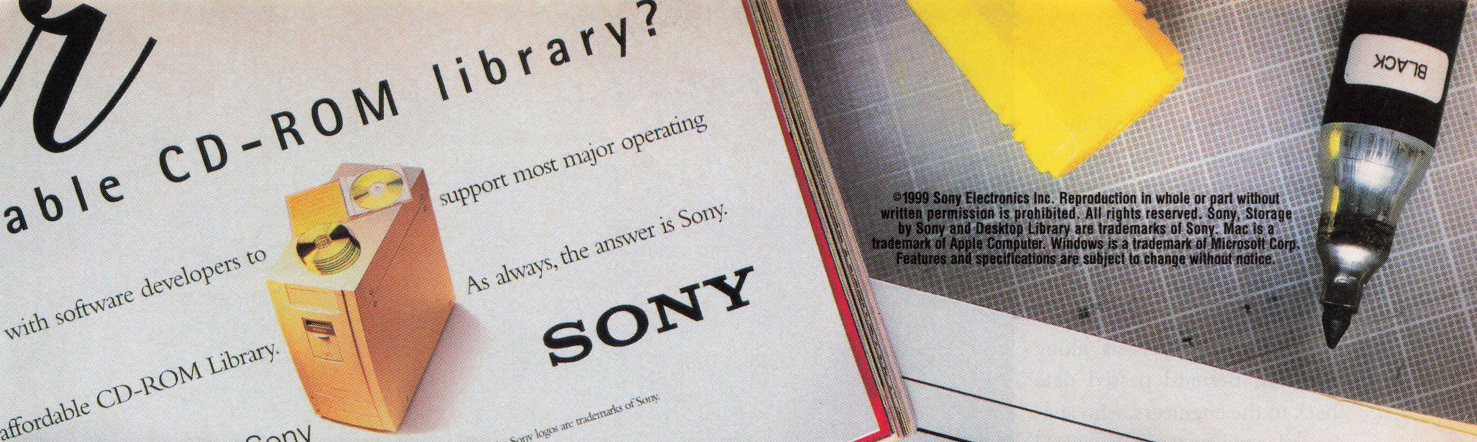

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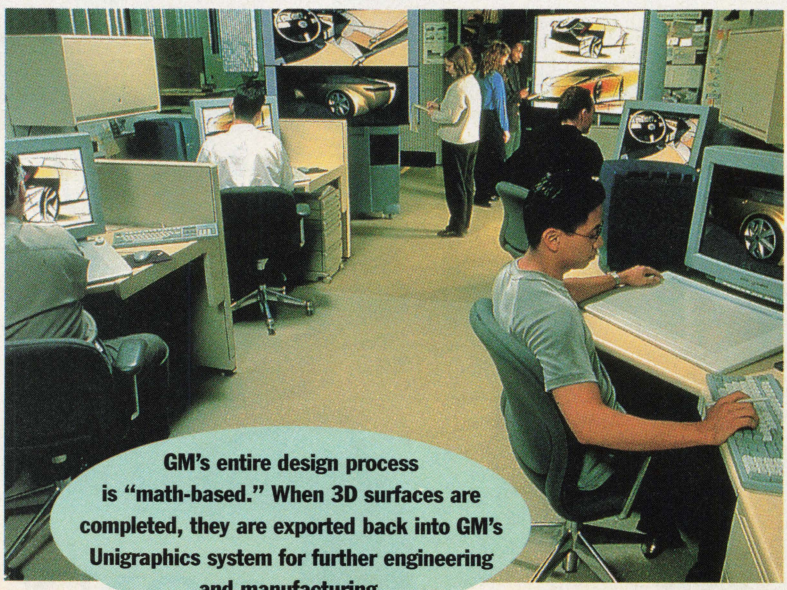
scopically display the 3D models. VR reduces the need to build physical models and helps designers resolve brand-styling concerns, architectural constraints, and manufacturing issues.

At regular intervals along the way, Bernard passed data back to the engineers, who suggested revisions, which could be implemented quickly in the digital model. Historically, automotive designers have created full-size tape drawings and generated clay models, which had to be rebuilt every time a change was implemented. In contrast, he says, doing the iterations digitally enables the designers to experiment freely without getting tied down to the physical models.

At GM, digital designs are reviewed using Visual Eyes, a virtual-reality application that displays interior and exterior models in stereoscopic 3D.

What's more, the process was highly efficient. "We broke all kinds of records in terms of reducing costs, development time, and human resources," Bernard says. At the same time, "the speed helped us maintain the freshness of the initial concept." When GM management approved the virtual model in what is being called a "ground-breaking" effort, Bernard exported the 3D interior and exterior surfaces back into GM's Unigraphics system for further development and ultimate manufacture.

The entire process was accomplished in what the company terms a "math-based process using math-based tools to create math-based models." According to Durmisevich, "When we're done designing, we have a complete math surface that we hand off to engineers, and we're well on our way to manufacturing the vehicle."



GM's entire design process is "math-based." When 3D surfaces are completed, they are exported back into GM's Unigraphics system for further engineering and manufacturing.

Math is the universal language between the design and engineering communities, notes Brian Baker, design manager for GM's Corporate Brand Character Center. "It allows simultaneous activities of widely divergent creative and technical groups. Since math tools have become much easier to use over the years, we believe that math has finally become a partner for the creative side of automotive design."

Styling Meets Design

In an automotive context, Baker says that in the past, design and styling were regarded as distinct functions with distinct associated skill sets. Designers were regarded as the more technical, engineering-oriented group, while stylists were more concerned with aesthetics. "In fact," he says, "for a long time, styling had a bad rap as being frivolous and superfluous, not as an essential requirement."

Today, GM has combined the skills required of designer and stylist into one function that is concerned with all aspects of vehicle development and must interact downstream with engineering and manufacturing. Says Baker, "Design and styling is recognized as the stage at which a product comes to life."

GM's new GTO and the rest of Detroit's new wave of retro cars represent the fruits of this hybrid process. In fact, as Jay Bernard would argue, in today's fast-paced design environment, creating these unique models—innovative designs that blend leading-edge form and function—could not be accomplished any other way.

Jeffrey Rowe is the principal of Cairowest Group llc, an independent design, multimedia production, and technical communication consulting firm in Salida, Colorado. He can be reached at jrowe@cairowest.com. Steven Ashley is a New York-based freelance writer who specializes in automotive engineering.

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creature feature

ANIMATORS USE 3D GRAPHICS TO HELP UNRAVEL THE MYSTERIES SURROUNDING SOME OF THE WORLD'S LEGENDARY BEASTS

BY KAREN MOLTENBREY

Throughout the last century, dozens of people have claimed to have seen Scotland's infamous Loch Ness Monster. A comparative handful of folks around the world say they have seen what appears to be a giant squid. And then there are the sporadic reports from those claiming to have caught a glimpse of the Australian giant lizard or the Tasmanian tiger (both thought to be extinct). However, no one person has laid claim to encounters with all these creatures—until now.

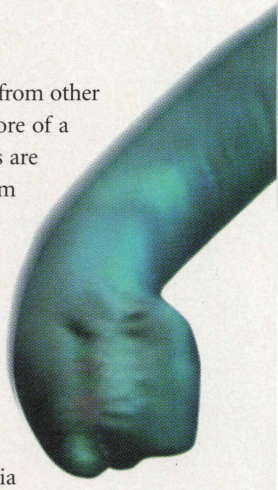
For months, Christian Hogue studied these legendary creatures, and spent equally as much time interacting with them one-on-one. As owner of Lost In Space, a digital-effects and animation house in London, Hogue and his staff recreated these legendary creatures for the BBC/Discovery Channel television series *X-Creatures*, which attempts to unlock the secrets surrounding these mythical monsters—and determine whether they are fact or fiction.

For a series such as *X-Creatures* to be successful, Hogue says, there must be an element of believability for some of the more fantastical creatures, especially following the release of films such as *Godzilla* and *Jurassic Park*. So, the clients began looking for a company that could provide realistic creature animation. "In order to do this project with a BBC documentary budget and still maintain a high level of quality, we couldn't afford to build the models like we normally do for a feature-film effect," says Hogue, whose feature creature credits include *Lost in Space* and *Terminator 2*. "Some of the *X-Creature* episodes only had one shot of the creature, so we had to do this cost-effectively." This meant buying as many CG creature models off the shelf as possible and using less-expensive hardware and software.

For the past nine years, Lost In Space has created effects for the film and commercials industries using high-end tools—for instance, SGI (Mountain View, CA) workstations and such software as Alias|Wavefront's (Toronto) Alias, Side Effects Software's (Toronto) Houdini and Prisms, and Avid/Softimage's (Montreal) program. But moving into broadcast production has pressured the company to find more affordable ways of producing digital effects that are comparable to those of the major US studios but can be created for a fraction of the cost. To test these new waters, the company decided to do the lion's share of the project using an Intergraph TDZ 2000 NT workstation running Kinetix's 3D Studio Max and Character Studio. "This was our first move onto an NT platform, and I have to admit, I've been very impressed with the results we were able to achieve, especially for the cost, using this approach," Hogue says.

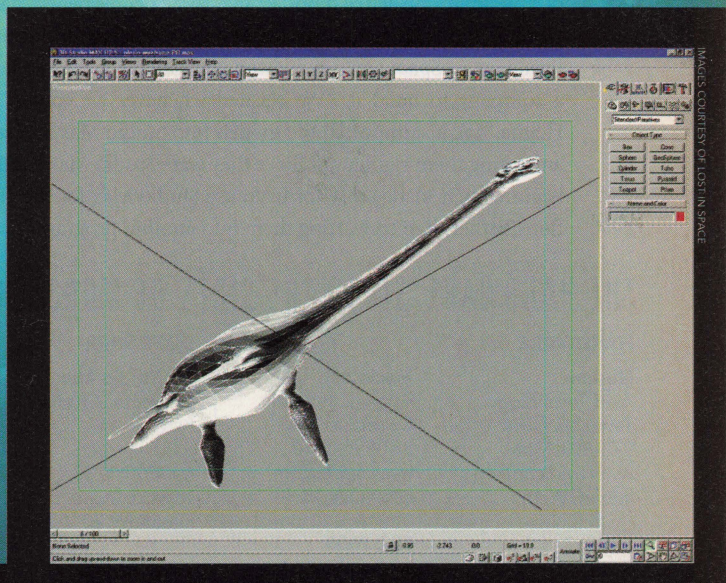
Creature Creation

According to Hogue, the series differs greatly from other natural history documentaries in that it is more of a suspenseful drama like the *X Files*. The shows are about animals that may or may not exist, from those as silly as Big Foot, which is probably a hoax, to those like the giant squid, which we know does—or did—exist, based on physical evidence.



"The series was approached from the perspective of a dramatic reconstruction of people's accounts of their encounters," Hogue says. "You never see the creatures in broad daylight, apart from the Megalania [giant lizard]. It's like the movie *Alien*, where you never see the monster in full; you see glimpses of it, which makes it more compelling."

Because of this approach, Hogue says, the modeling requirements weren't as stringent because the audience sees the creatures fleetingly, as if in an actual encounter. At the same time, however, the animators had to create more dramatic and realistic effects because the scenes were intended to fit a real-life context.



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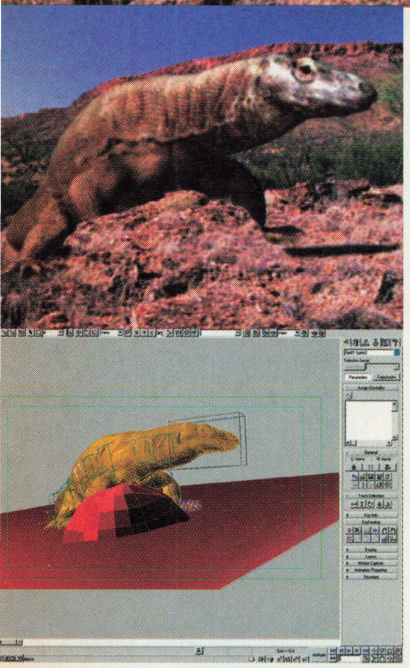
The success of *X-Creatures*—which already aired on the BBC and is scheduled to run on the Discovery Channel—hinged on the believability of some of the fantastical creatures featured in the television series. To achieve that goal on a documentary budget, though, required London-based animation facility Lost In Space to abandon its high-end graphics tools for lower-cost NT-based hardware and software. This enabled the animators to purchase as many off-the-shelf models as possible, such as this plesiosaur, which provided the basis for the Loch Ness Monster.



To create the giant lizard, the artists imported an REM Infografica model of a monitor lizard into 3D Studio Max, then animated it using the software's biped controls.

IMAGES COURTESY OF LOST IN SPACE

In keeping with the series' dramatic, realistic tone, Lost In Space animators worked closely with BBC researchers to determine the look of each monster. "Even with all the scientific research, there are still debates about what color the dinosaurs were, for instance, because a lot of that material didn't survive the fossilization process," Hogue explains.

To keep the project costs low, Lost In Space purchased CG models for as many of the creatures as possible. To create the Megalania, or giant lizard, the group bought a standard REM Infografica (Madrid, Spain) model of a monitor lizard, and scaled it to fit into the scene. The artists also purchased a standard model of a plesiosaur, an actual dinosaur that some people believe has survived as the Loch Ness Monster. For the thylacine, or Tasmanian tiger, Lost In Space couldn't locate a comparable model, so it hired a company to build it. "We cheated whenever we could," notes Hogue. "We just imported the models into Studio Max and started animating them right away. Since they were Studio Max models to begin with, it made sense for us to use Studio Max for the animations, rather than converting them into another program."

According to Hogue, using the NT tools allowed the animators to cut their work by a third, since they didn't have to spend weeks building the models by hand. Also, by using Character Studio, for instance, the artists could streamline the animation process, since they did not have to build the creatures' skeletons from scratch, as required with Softimage. In fact, the Tasmanian tiger model contained a built-in skeleton along with a run cycle. "We got all that for the price of a model," he adds. "This was a great way to work."

However, not every creature was created so easily. Because the modeling for the giant squid was so intrinsic to the way the creature was to be animated, the Lost In Space animators chose to create the creature themselves, which took about a week using 3D Studio Max. "It took a lot of time to nail down what the squid should look like. No one has seen one alive, and their bodies tend to be quite decomposed when they are discovered on beaches," says Hogue. Once that issue was settled, the group began the modeling process, but found it difficult to attach the tentacles to the body in a believable manner. "So we didn't actually attach the tentacles to the body; the tentacles were the body. On the outer layer of main tentacles, we made a smooth cylinder that is similar to an orange, where each segment was potentially a tentacle. Just in front of the eyes, the tentacles open and spread out," he explains. "However, it was a challenge getting the arms built so they blended into the body correctly based on the look we had chosen."

To texture the giant squid, the group used photographs of actual squids as a reference, then tried to match those textures using Max's built-in tool set. The prebuilt models, however, were shipped already textured. For all the rendering, the artists used 3D Studio Max's renderer.

Having an Effect

To composite the work, the animators used Silicon Grail's Chalice running on an SGI Indigo2 High Impact workstation and Adobe Systems' After Effects running on a Macintosh and NT platform, then presented the completed shots to the client. In some cases, where the group supplied only digital elements, the compositing was completed by the BBC's Natural History unit using an Avid Technology Illusion.

"After Effects was not only affordable, but it also has a wide range of plug-ins that proved very useful, especially for the organic work," most of which was done for the squid shots, says Hogue. For instance, the animators used some MetaCreations Final Effects filters "to create organic light effects for the giant squid as it emerges from the darkness and appears in front of a

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diver." The group also used LightBurst, a Final Effects plug-in, to produce algae blooms of light flashing in the background for the same sequence. To mimic the giant squid's natural ability to bio-illuminate, the animators turned to Chalice. "The giant squid has the ability to pulse with an inner luminescence and can actually change color. When it does this, it can look like something out of a science-fiction movie rather than a documentary, which is precisely the edginess the director wanted," he adds.

IMAGE COURTESY OF LOST IN SPACE

Although shots of the giant squid appear artistic in nature, the artists spent a lot of time researching the creature, even setting up a Web site so that squid experts, such as the Smithsonian's Clyde Roper, could provide feedback on the the CG creature's structure, color, and texture.

"So instead of using complicated shaders to generate the bioluminescence, we cheated and did it much faster as a 2D post-processing task in Chalice."

He continues: "We composited the creature shots ourselves because we wanted to make sure our computer graphics matched well within the live-action plates. Previously, we were more of a 3D graphics boutique. We would do some compositing, but most of the work was sent out to a larger post house. Now, we can do that work ourselves in D1 quality very quickly—at speeds similar to those achieved with Discreet Logic's Flame but using hardware and software that costs a fraction of the price."

Indeed, extraordinary effort was put into the live-action sequences, as the BBC crew traveled the globe to find the best locations for each segment. For the program on the giant squid, director Peter Nicholis persuaded NASA officials to allow him to film an astronaut suspended in a massive water tank used to mimic the weightlessness of space. He orchestrated a strangely hypnotic sequence of shots in which viewers see an astronaut floating in what appears to be space. Gradually, almost imperceptibly, what seem like tiny stars become eventually recognizable as miniscule particles of matter in an underwater environment, explains Lost in Space producer Shireen Armstrong. From there emerges the giant squid. For that sequence, 3D Studio Max proved especially useful, Hogue maintains, because the animators

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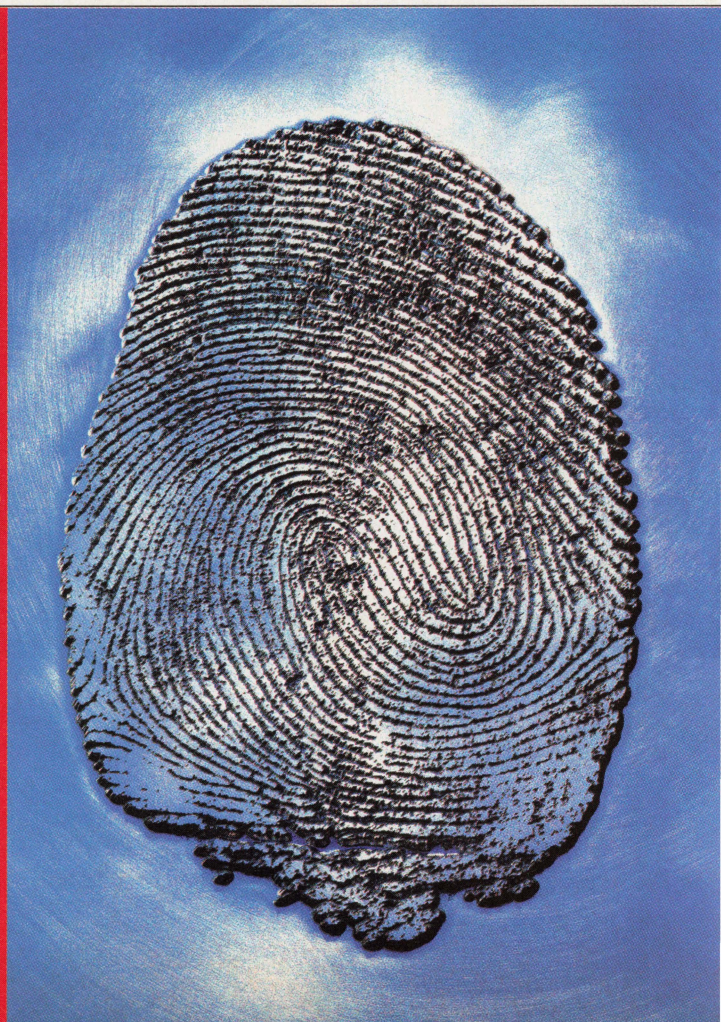
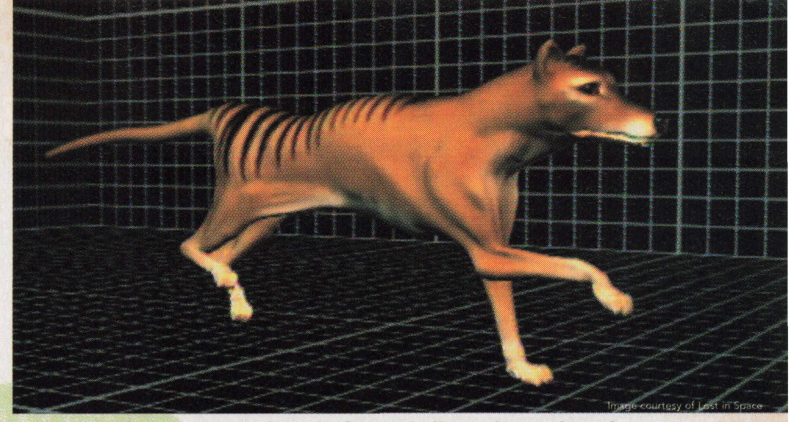


could more easily project the live-action plate onto volumetric atmosphere in the scene containing the CGI creature, greatly enhancing its ability to blend into the live action.

For the Loch Ness sequence, the group used Xaos' Pandemonium to create an optical-distortion effect, mimicking a heat-haze effect, while re-creating the first "official" sighting as the creature walked across a back road during a summer day in 1920.

While NT tools dominated the project, the Lost In Space crew did rely on its standard software in certain instances. For a series of squid shots, in which the creature was close the water's surface, the animators used Softimage. But matching the look of the water to the live-action plate with the appropriate distortions proved especially difficult. "It wasn't the most successful part of the project. Now, we would definitely take advantage of the increasing number of plug-ins, such the water-simulation software from Arete Entertainment [Sherman Oaks, CA]," Hogue says.

Considering the three-month time frame, Hogue believes the group achieved better results than it would have by approaching the project using more expensive systems. "For us, the project was sort of a trial for how a studio like ours—which has been at the high end [of the animation market]—can broaden our markets into broadcast and feature-film work by moving toward NT and using software like Studio Max and After Effects. [Those tools] made it cost-effective for us to work on this project, and we didn't sacrifice anything at the end of the day. We felt that these tools were just as good as the more expensive ones running on SGI boxes," he says. Plus, the tools enabled Lost In Space to complete the project on time and within budget.



By using NT-based tools, Lost In Space believes it can broaden its reach into other animation markets, such as broadcast documentaries.

In fact, Hogue found the experiment so successful that he purchased NT-based Max Black (London) workstations, along with an NT-based Matrox (Montreal) DigiSuite video-editing system running In:Sync's (London; Bethesda, MD) Speed Razor, After Effects and Chalice.

"It's quite a revolution for a small studio like ours to be able to offer a much broader range of options to our clients," he adds. "We believe the broadcast market—especially the documentary and natural history areas—holds a lot of potential for us, but we have to be able to do the work within the right budget. So for us, this project was an important test to see what tools and methods we could use to bring our skills to this segment at the right cost."

Karen Moltenbrey is an associate editor of Computer Graphics World.

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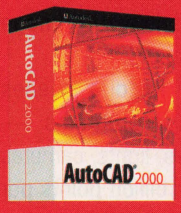

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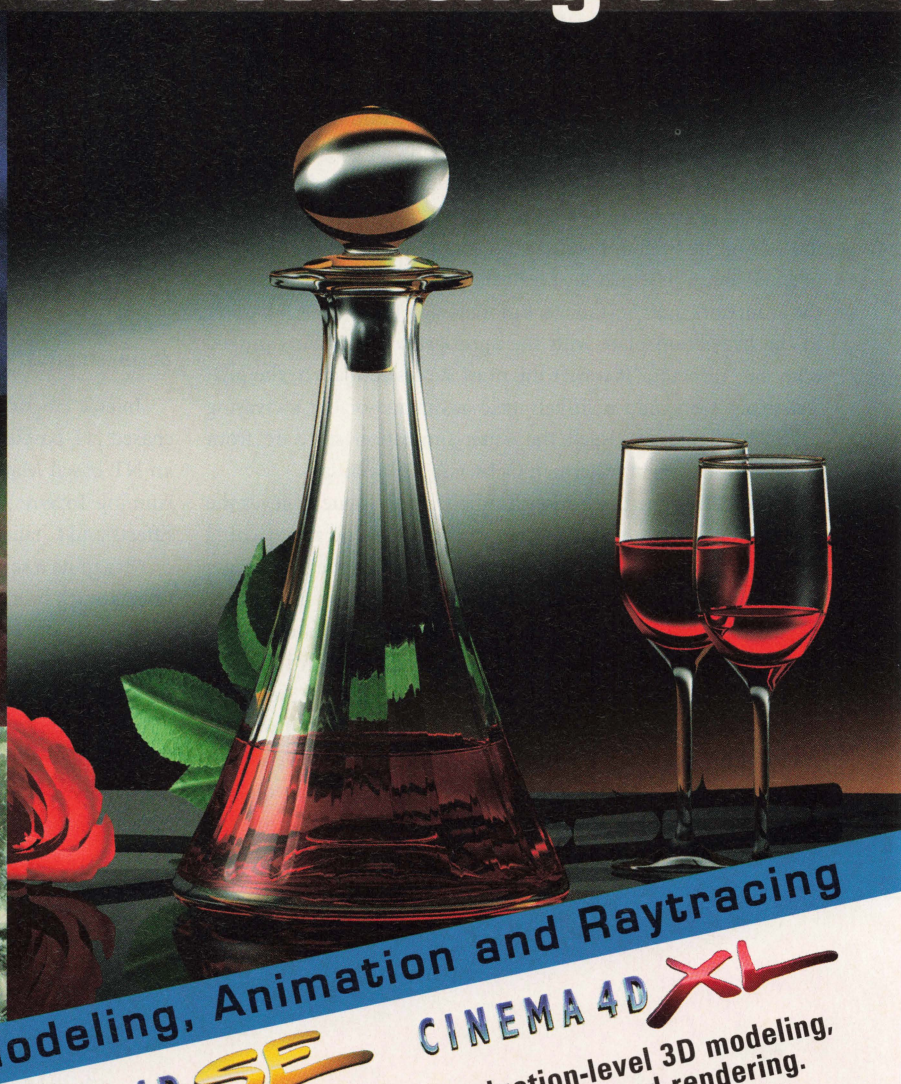

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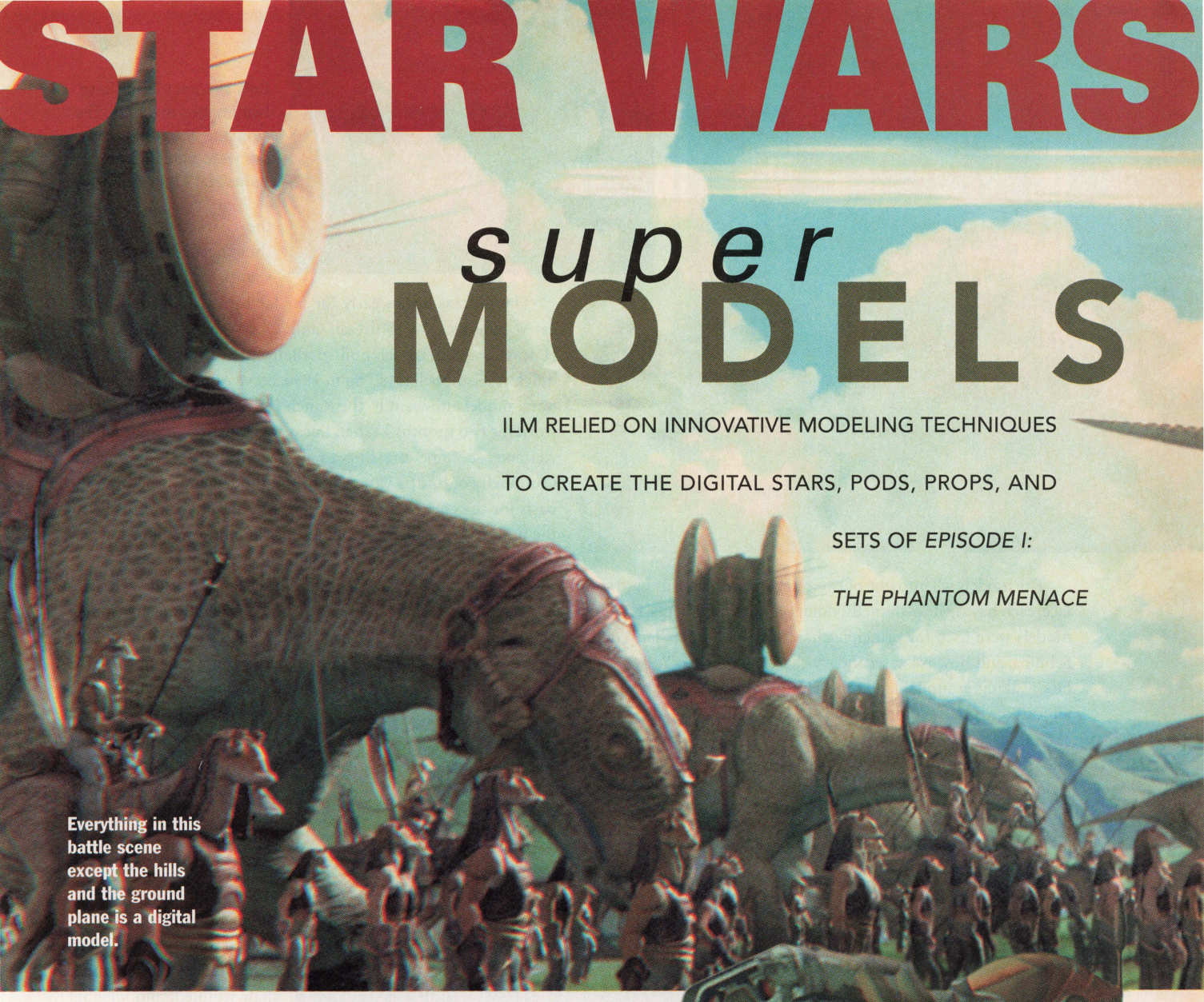
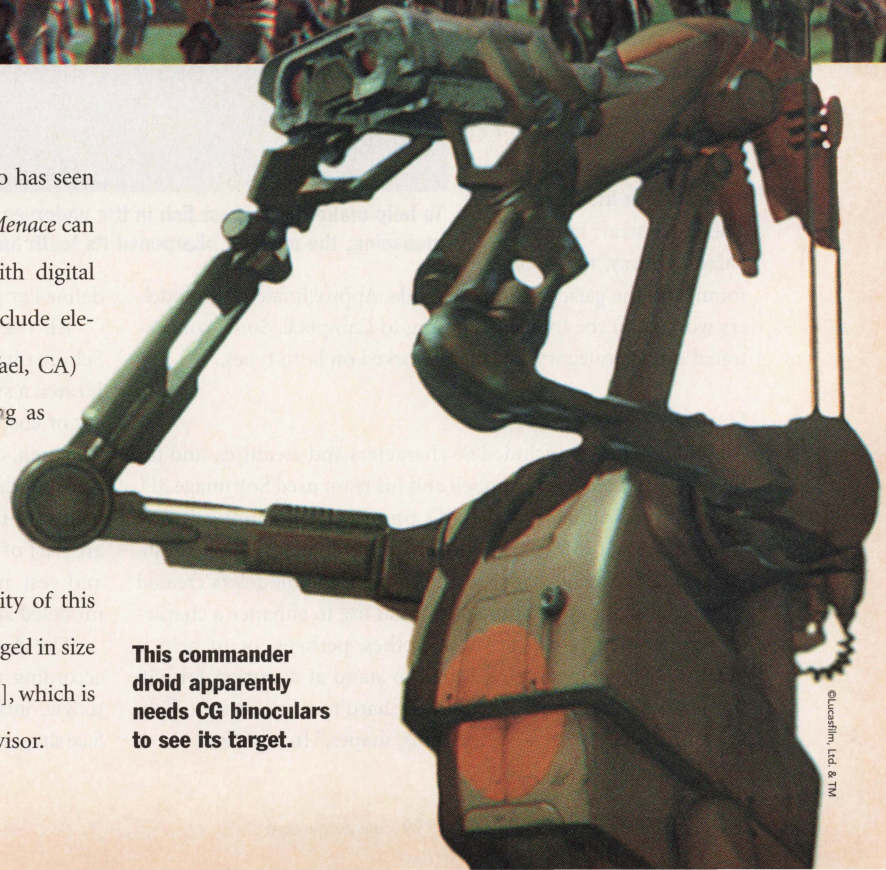


Everything in this battle scene except the hills and the ground plane is a digital model.

BY BARBARA ROBERTSON

There's at least one thing everyone who has seen *Star Wars Episode I: The Phantom Menace* can agree with: This movie is filled with digital visual effects. Indeed, most scenes include elements created at Industrial Light & Magic (San Rafael, CA) with computer graphics tools—elements as imposing as digital characters and space ships and as invisible as set extensions. When you stop to think that each little bit of computer graphics (with the exception of pure particles) had to be modeled, the sheer enormity of this effort can't fail to impress. "We created models that ranged in size from as small as a mosquito to Fambaa [a huge animal], which is 30 feet tall," says Geoff Campbell, digital model supervisor.



This commander droid apparently needs CG binoculars to see its target.

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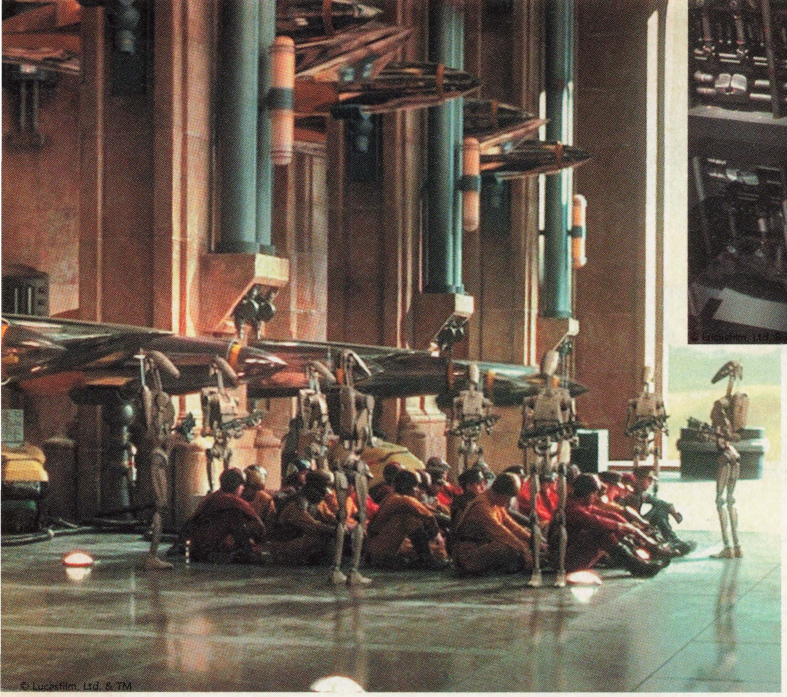
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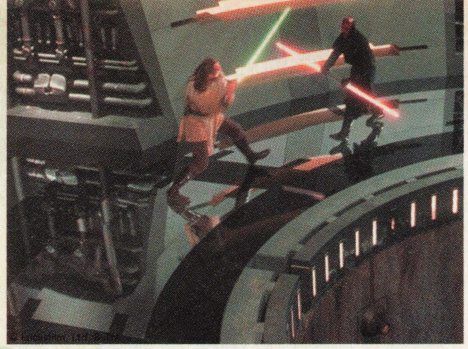

Only the people in these two images are real. The sets and the droid troopers were modeled at Industrial Light & Magic.

The models fell into one of two categories, organic or hard surface, each having its own methodology and requirements. Organic models were used for principle characters such as Jar Jar, Watto, Sebulba, and Boss Nass; secondary characters such as Yoda (when he's walking around), Jabba the Hutt, the two-headed pod-race announcer, pod-race drivers, several varieties of animals and "fish;" plus many background characters. Hard-surface models were used to create props that ranged in size and complexity from saddles and reins to energy balls. Hard-surface models were also used for droids, space ships, racing pods, the Gungan submarine, and for a few sets. While most exterior shots used miniatures, CG models were used to extend or create four interior sets: the Theed central hangar, the palace hallway, the generator room, and the galactic center rotunda. Approximately 18 modelers worked on the movie, according to Campbell. Some concentrated on one category, but many worked on both types.

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To help make the biggest fish in the undersea Gungan world look menacing, the modeler sharpened its teeth and gave it tiny eyes.

Shaping Characters

All told, the movie included 66 characters and creatures, and for these organic models Campbell and his team used Softimage 3D, Alias Power Animator, and ILM's proprietary I Sculpt software running on SGI workstations to create and shape the basic mesh. For models relatively close to the camera, the modelers created additional shapes that animators could use to enhance a character's performance—to move its clothes, perhaps, or to help it breathe. "The Gungan guards had to stand at attention for 360 frames," says Campbell. "That's really hard to animate, so to help the animators, we created breathing shapes." In addition, six of the characters talked and thus needed libraries of shapes for lip synch.

The process began early for Jar Jar Binks, the gangly, long-eared side-kick to Qui-Gon and Obi-Wan Kenobi. "George [Lucas] wanted Jar Jar built digitally to see facial expressions quickly," Campbell says. "So in 1996, Steve Applin and I roughed out a model and went to the Ranch [Lucasfilm headquarters] to work for two months." When Lucas was satisfied with Jar Jar, the character became the first to be fed into the ILM pipeline. Campbell continued working on the model, and it became the basis for the entire Gungan species. Applin moved on to Watto, the junk-dealer with an elephant nose and hummingbird wings, and Paul Giacoppo took on Sebulba, the nasty pod racer.

For each new character, the modelers worked with Tim McLaughlin, a technical director who considered the enveloping and simulation, James Tooley, who designed the constraints (the chains), Jean Bolte, a painter, and designer Doug Chiang. First, the group would decide how much detail a character would need. "Some of the pod racers would go by so fast that we could build a low-res character that was almost a card, a projection onto a plane," Campbell says. For high-res characters in the foreground, they would determine how the character needed to move, how much of it could be painted rather than sculpted, and whether the character needed facial expressions and lip synch. Once they started building the models, the animation group became involved, and together the teams began to define key poses for facial expressions and lip synch.

All the characters in the movie wore clothes—Watto and Sebulba had leather vests, Boss Nass and Yoda wore robes, Jar Jar tied a sweater around his waist, and the Gungans had a variety of costumes depending on whether they were soldiers, calvarymen, civilians, or principal characters. Some of the clothes were modeled separately to make it possible to animate them using simulation software. "Jar Jar's pants and undergarments are part of his body mesh," explains Campbell. "But his sweater and vest are modeled on top." Similarly, Boss Nass's robes are modeled separately for the simulator.

The clothes added complexity to the already complex models, according to Li-Hsien Wei, who worked on 20 models for the movie, including Captain Tarpals (a Gungan soldier), Sebulba's face shapes and clothes, two additional pod racers, and several ani-

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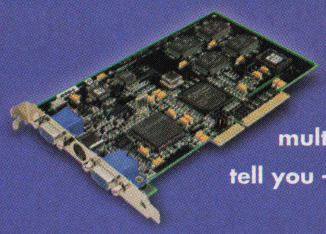

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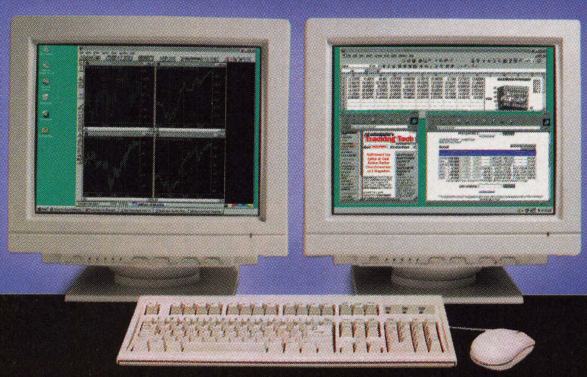

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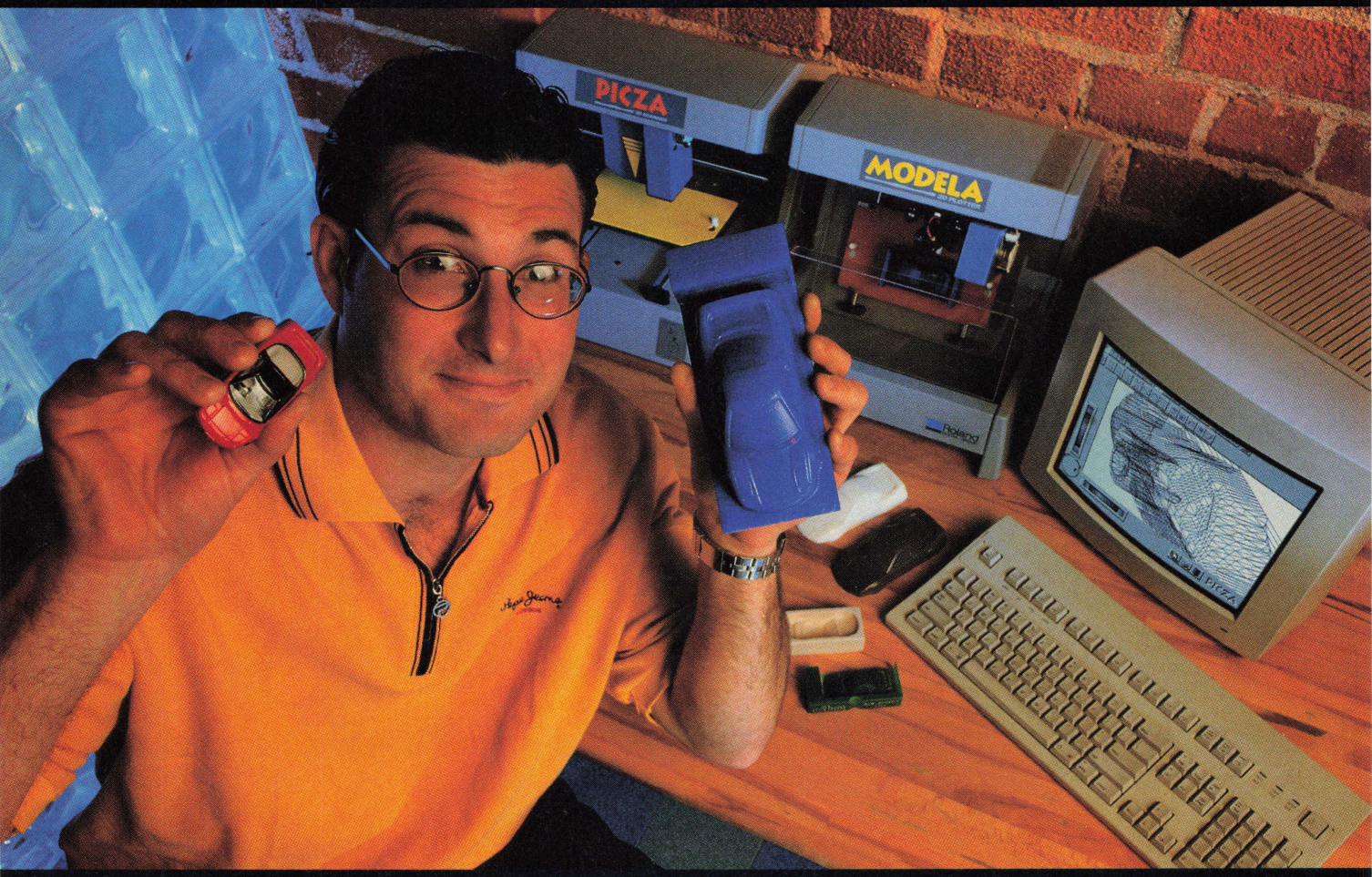

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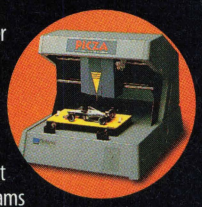

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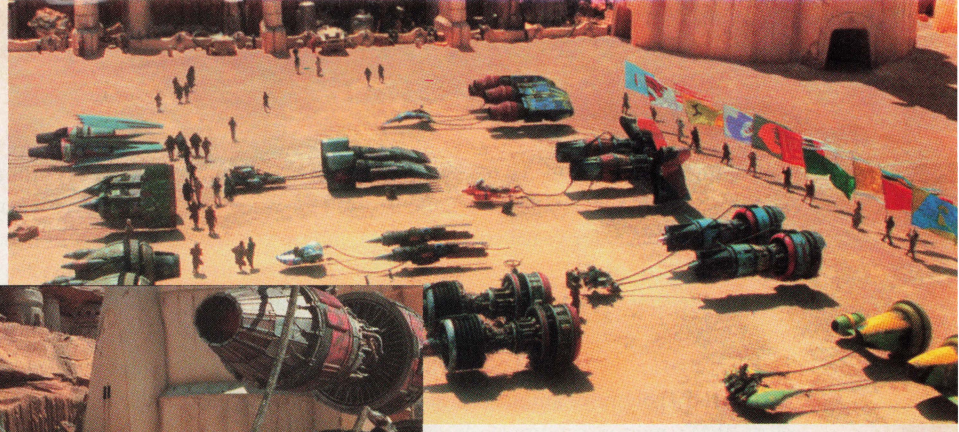
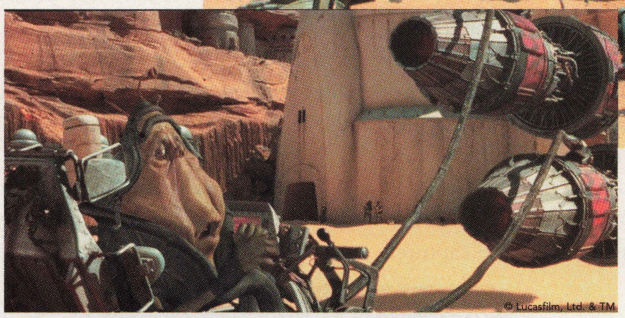


A few of the 18 pods, which are CG models when moving, are lined up (at right) for the start of the race. The pod racers are always digital, although that didn't help the racer below get off the ground.



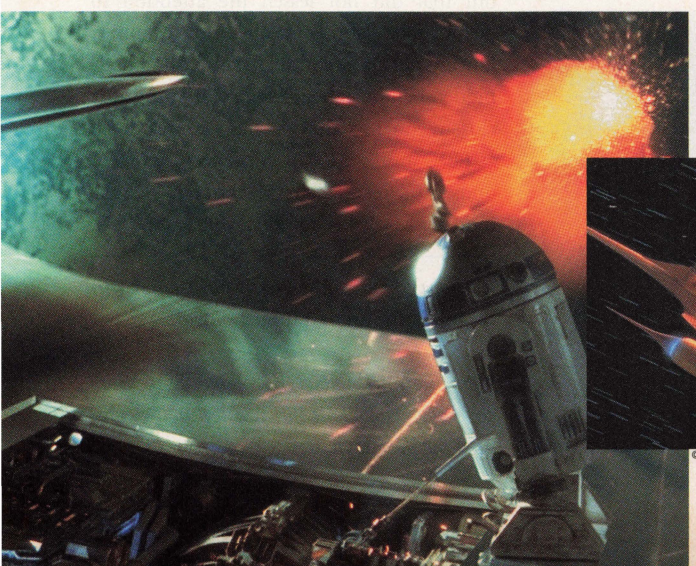
mals. "Sebulba is close to Draco in size," he notes, referring to the hefty, complex dragon model in the movie *Dragonheart.* "Fortunately, the computers are getting faster, and our software is good for working with heavy models." Wei created basic structures with Power Animator, reshaped volumes to do such things as lengthen arms and enlarge heads with I Sculpt, and manipulated CVs (control vertices) for the B-spline models using Softimage 3D. For example, to transform Jar Jar into a model for Captain Tarpals, Wei used I Sculpt to make global changes to the body; but for Sebulba's facial expressions, he used Softimage 3D to create detail around the eyes. For the Eoopie, a four-legged llama-like creature with a snout, and the Kadoo, a kangaroo-like animal, Wei started by using I Sculpt to reshape 3D scans of maquettes.

Creature artist Alyson Markell, however, created the Dewback, a lumbering lizard-like creature, the Ikopi, a deer-like animal, and the head of Sando, a huge underwater creature, from scratch. "I'd get the basic proportion in Softimage or Alias, then would pretty much hand-sculpt the model from there using I Sculpt to add muscles, shapes, and skin folds." One character for which skin folds were especially important was Jabba the Hutt. "I started with Jar Jar's model, then began deforming it by adding face shapes, breathing shapes, and muscles in his chest and stomach," she explains. Then she modified Jabba's model to create his mother. "I use the same geometry so I can keep the same patch names and counts. As long as the numbers and names stay the same, I can deform it [with some restrictions]", she says. "If the model is going to be animated, I can make the new one wider or thicker, but not longer than the chain in the original."

The hard-surface models that most resemble character models are those for the droids. These models were chained with skeletons for animation as were the organic characters; however, the droid models, many of which would be animated with the help of motion-capture data, had particular characteristics that affected their movement. For example, they had pistons between their hips and chests. Also, "a motion-captured head might move from side to side," explains Paul Kavanagh, technical animator, "so we built restrictions into the droid model to prevent too much movement." And since many of the droids would be destroyed, they were designed to easily come apart. Thus, despite the fact that these "characters" could walk and talk, they were modeled using techniques that might have been used for other machines.

Hard Surfaces

"When you're sculpting a creature, you're pulling CVs to create the shapes," says Russell Paul, lead hard-surface modeler. "But when you're creating a machine, you work with definite, abutting surfaces." Paul, who left Alias|Wavefront's Industrial Design group in Toronto to join ILM, used Alias|Wavefront's Studio running on SGI workstations for modeling the destroyer droids, the Gungan submarine, racing pods, the Naboo Starfighter, and the all-chrome queen's ship. "In some cases, the process is different from industrial design because you are creating an illusion," he says. "You can paint holes, for example, and you don't always have to model them." But because the queen's ship was totally reflective, they couldn't cheat with bump maps and paint. "We built the queen's ship just like a car," he says. In fact, ILM milled a seven-foot-long model from CG data and used that model in shots when the ship sat on the ground. For the space-battle sequences, models for the Starfighter and the queen's ship were both converted to polygons and imported into formZ from autodessys (Columbus, OH) running on Macintoshes.



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The queen's ship (left) and the Naboo N-1 Starfighter (below) were modeled using techniques familiar to computer-aided industrial designers.

In addition to the space ships, the modelers used Studio to create 18 different pods for the pod race, which was no small task. "Anakin's pod had 3700 surfaces," Paul says. "We learned how to be more efficient, though: The number of surfaces in Sebulba's pod went down by 1000." To further help save time, various pods were created with low,

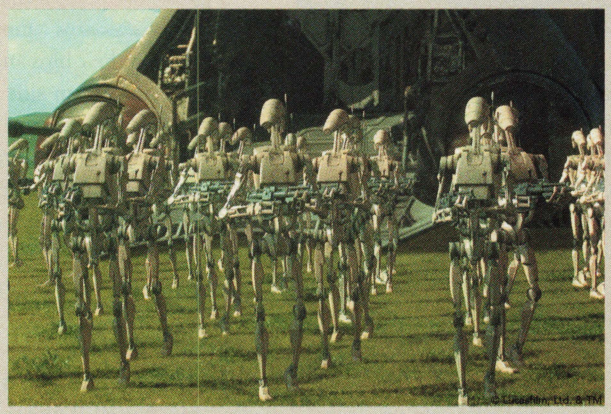
GOOD MOVES

Some animators call it the devil's rotoscope. Although motion capture was used successfully for *Titanic*, it's been the exception rather than the rule for visual effects. At ILM, mocap was tested, but not used for *101 Dalmatians*; tried for *Casper* but used only for one shot of Casper's mouth, and also used in a quick shot for *Spawn*. Then *Star Wars Episode I* made it viable to consider motion capture in a big way. "There were so many scenes that needed a volume of animation," says Jeff Light, who helped set up ILM's motion-capture studio and became motion-capture supervisor for *Episode I*. The studio now has a well-utilized Oxford Metrics' 20-camera Vicon 8 optical motion-capture system, from Vicon Motion Systems (Tustin, CA). "We captured hundreds of performances," says Seth Rosenthal, motion-capture supervisor for the studio.

For *Star Wars*, motion-capture data helped create animatics (animated storyboards) for previsualization, became reference material for keyframe animators, and provided animators with motion cycles they could use for the Gungan soldiers and battle droids. To create the animatics, Light acted out the entire film while wearing Ascension Technology's (Burlington, VT) wireless magnetic motion-capture system. Keyframe animators working on Jar Jar had reference data captured from actor Ahmed Best, who wore optical markers for the Vicon system, as did Light and James Tooley, who performed the Gungans and droids respectively. "James and Jeff could perform to the plate," says Rosenthal. "They knew clearly what the shots entailed because they were responsible for them. We were able to do emergency shots in the morning and see them in dailies a day or two later," he adds.

This animation efficiency was due in part to software ILM developed. "I didn't like motion capture any more than any animator would," Light says, "so I decided I'd [create a system] from an animator's perspective." As a result, when an animator gets motion data, it's already applied to the hierarchy of the character, so the animator can easily use all or any part of it.

Now that *Star Wars* is over, ILM is using motion capture for other projects. Already the motion-capture studio has been put into action for another movie, *The Mummy*, and has helped design a creature for a game developer.



"Mocap" data helped animators move the droids.

medium, high, or "hero," resolutions, depending on how close the camera got to the pod. Paul also applied techniques such as trims from his industrial-design background. He used trims in particular for the complex destroyer droid model, which folds up and compresses into a wheel. "ILM hadn't used trims before; their 3D paint software didn't work with them," he says, "so to create a hole, they had to create new patches." Thus, ILM's R&D department updated its Viewpaint software to allow painting on trims. In addition, the painting software incorporated projection mapping, which opened the door to polygonal models. "For hard-surface models, in some cases it made a lot of sense to use polygons," Paul says.

ILM modelers created special shapes for Jar Jar's tongue (left), and carefully folded the geometry in Jabba the Hutt's model (below) to create the folds in his skin.

One of the most complex models Paul worked on was the droid rack, a huge machine that delivers the battle droids to the battleground. "I got to animate the mechanism that drops the droids into formation because I was the only one who knew how it worked," says Paul. For that, he used Alias|Wavefront's Maya software.

Like the droid rack, many models appear only briefly onscreen, but that did not lessen the attention to detail. Take Jabba's mother, for example. During her 15 seconds of fame, she's half-hidden behind Jabba. Even so, if you watch closely, you'll see that she has as much detail as her son. It's a lot of effort for a few seconds on screen. "Tell me about it," laughs modeler Markell, "but it was fun."

Barbara Robertson is West Coast senior editor for Computer Graphics World.

Next month, in Part III of our Star Wars *coverage, we look at the new technology created for the movie.*

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The Harem Veiled

PHOTOGRAPHIC IMAGERY AND COMPUTER GRAPHICS CREATE AN EXOTIC LOOK FOR A GRAPHIC NOVEL

Costumed models (left) were posed, then photographed to represent the characters in *Veils*. The photographs were placed into digital scenery.

BY JENNY DONELAN

The hidden world of the harem, with its hints of exoticism and decadence, has always intrigued Westerners. Vivian Pearse-Packard, the 19th-century heroine of Vertigo/DC Comics' new graphic novel, *Veils*, is fascinated by and eventually drawn into this lush, languid world. The motivating force behind the book itself, says originator Stephen John Phillips, was a fascination with "Turkish dens, smoking rooms, harems, and sultans."

Even in the rarified world of graphic novels, which push the envelope of the comic book genre in terms of artistic endeavor, *Veils* stands out. The 90-page hardcover book owes its uniquely sumptuous, dreamlike look to characters that were photographed in a series of tableaux and then combined, using Adobe Systems' Photoshop, with a series of backgrounds that were either photographed, drawn in 2D, modeled in Softimage, or created using a combination of the three techniques. Paintings, etchings, and textures from 19th-century works of art were also used, creating a sequence of story panels that look a little like photographs, paintings, or collages but not quite like any of them.

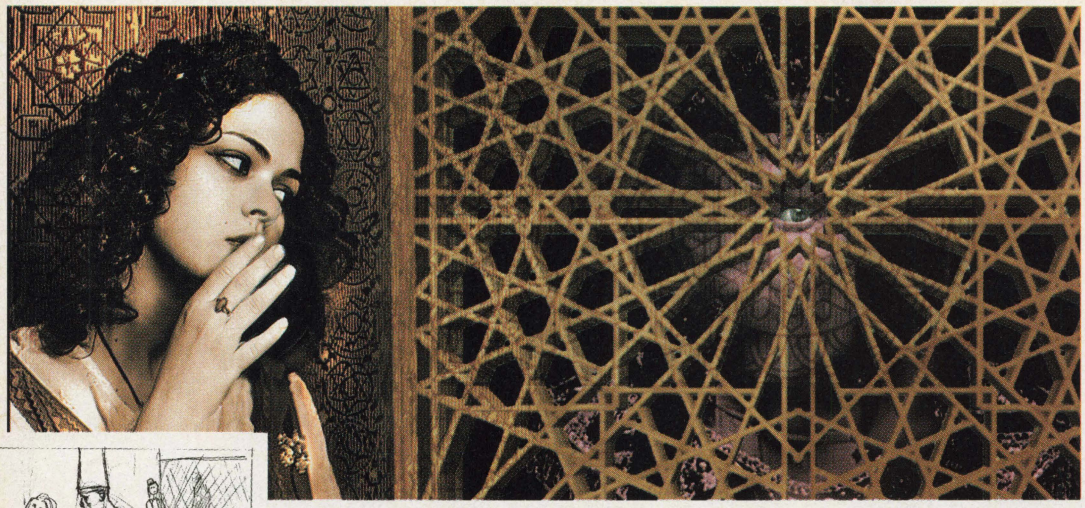
This format suits the fantasy storyline of *Veils*, in which an unhappily married Englishwoman becomes embroiled in a mystery involving the sultan's court. The action takes place in a nameless, exotic land of the last century. Elaborate mosaics, open-air markets, hookahs, and of course, the exotically clad women of the harem add atmosphere to the tale.

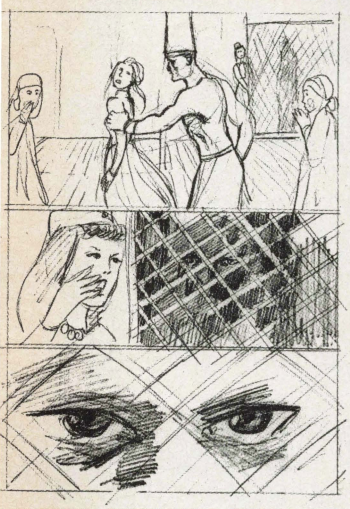
The idea for *Veils* arose from research for a cigar smoking room. Phillips, a fine-art photographer who specializes in shooting figures for narrative scenes, was commissioned to create photographs of people smoking hookahs and cigars for the room. That project inspired him to create a work called "Harem Pictures," which he and author Pat McGreal subsequently used to present the premise for *Veils* to DC Comics. "At that point," says Phillips, "they were interested but a bit cautious because there hadn't been any completely photographic graphic novels made, and they weren't sure how we could put it together." So Phillips contacted digital artists Jose Villarrubia and Aleksey Zolotaryov, who created CG environments to complement his pictures, and the project was sold.

Veils was a collaborative effort from start to finish. Villarrubia, originally trained as a painter, first penciled a storyboard based on McGreal's script. The sketches portrayed the characters' actions and emotions in some detail, because both Villarrubia and the editors wanted to make as many refinements as possible prior to the photo shoots. Then, using Villarrubia's layout, Phillips photographed live models, posing them in positions that corresponded to Villarrubia's pencil drawings. Says Phillips, "Jose is excellent at showing emotions, even in simple figures. So if a woman he drew looked surprised, I would work with the model to make her look surprised, or show whatever emotion was appropriate. That was difficult at times, because in a drawn comic, you can get away with really big gestures, but if you try too much of that in a still-image photograph, it can look kind of kitschy." Throughout the project, the books' creators took pains to avoid creating a camp or "over the top" look.

Locating the right models for the characters also proved a challenge. "For the lead sultana, for example, says Phillips, "I needed a very old woman who had once been very beautiful." Finding the right sort of large man to portray the unsympa-

A 19th-century painting (center inset) served as the inspiration for the harem bathhouse (background), which was modeled in Softimage, then populated with photographs of models (below inset) using Photoshop. Photos of clouds were used to create the smoke and steam effects in the room.





An original sketch (left, center panel) of the character Pakize looking toward a screen ultimately became a montage of photography (above, left) and 3D graphics (screen at above right). The screen was created in Softimage.

thetic character of the sultan was also difficult, until Phillips located professional wrestler Mad Dog (O'Malley).

Villarrubia scanned in Phillips' photographs, many of which were in black and white, then integrated them with the digital backgrounds using Photoshop running on an Apple (Cupertino, CA) Power Macintosh 8500. **For the CG environments, he used 19th-**century paintings, old postcards, etchings, and contemporary photographs of Turkey. (Though the city in which the story occurs is never named, it is based primarily on Istanbul.) All the scenes that take place in the harem are based on pictures of actual harem rooms. Villarrubia also used scanned sections from old paintings. Ultra-realism was not a goal for the novel's creators. "The look of the book is not exactly what harems and bathhouses looked like," says Villarrubia. "It's more about the Western, 19th-century interpretation of these. *Veils* is in the tradition of travel books of that period that were written about the mysteries of the harem."

For the final sequence of the story, which takes place in the bathhouse, Villarrubia decided that a grand 3D space would look best, so he asked Zolotaryov, at the time a computer graphics student at the University of Maryland, to create it. Using Softimage on an SGI (Mountain View, CA) workstation, Zolotaryov based his image on *The Great Bath at Bursa,* an 1885 painting by Jean-Léon Gérôme. To create light and reflections, he used Mental Ray, a Softimage plug-in. He also designed an ornate screen in Softimage that is central to the storyline, and which appears in many of the panels. Re-rendering the images in the different colors and lighting required for the different scenes was time-consuming; so for proofing purposes, he rendered the images at low resolutions and posted them on the Internet, where Villarrubia could review them prior to full rendering.

Zolotaryov originally tried to create the smoke and vapors for the bathhouse but was disappointed with the results. "The [older SGI] machine I was using at school wasn't quite powerful enough," he says. "And there wasn't enough memory to create nice smoke effects. The best I could do was distribute the light properly." To create the foggy atmosphere of the bathhouse, Villarrubia eventually overlaid the room with photographs of actual clouds.

Throughout the project, Villarrubia had to be careful not to let the capabilities of the software overshadow the whole effect. "With Photoshop, there's an incredible danger of making images look too airbrushed and plasticky, and the same thing can happen with three-dimensional programs like Softimage," he says. Adds Phillips, "Things can look too clean, and not believable. From the beginning, I said to Jose, 'If we can start with the real thing, it's better.' I wanted pictures of real smoke, like the smoke that's coming from the hookah in the sultan's chamber." Says Villarrubia, "There's a certain look to computer-generated flames and smoke and water. It's flashy, but it's very recognizable. So although there are hand-drawn images in this story, most of it is hand-drawn retouchings and so forth."

Without computer graphics, however, *Veils* would not have been feasible. "We would have had to go to Morocco," says Phillips, "or build sets, which would have been incredibly expensive and time-consuming." And of course, the curious blend of 3D, 200-year-old paintings, photographs, and Photoshop effects gives this graphic novel its unique look.

Whether *Veils* will start a trend of similar efforts remains to be seen. The book was complicated to produce and expensive to print. One of the biggest expenses was the paper. "We couldn't use newsprint like a regular comic," says Villarrubia. "And the jury is still out on what the comics industry will think of it. There are lots of purists in the comics world who only like artwork done with pen and ink. I think there may be some reticence to photographic imagery."

On the plus side, *Veils'* creators hope the book will appeal to people who don't normally read comic books, or even graphic novels. "We're hoping to have some crossover," says Villarrubia. "People who would buy an art coffee-table book might buy *Veils.*"

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COMPUTER GRAPHICS WORLD

INNOVATION IN VISUAL COMPUTING

deep background

BY BARBARA ROBERTSON

It's easy to understand why, when considering how to create the first full-length animated film of Tarzan (released mid-June), the directors at Disney Feature Animation wanted to push through the restrictions of traditional cel animation and give the king of the jungle ample room to surf down tree trunks and swing from branch to branch like his gorilla brethren. "I wanted to take the camera into the trees," says Dan St. Pierre, artistic director, "to create an environment Tarzan could move through." The question was how. In cel animation, whether it is created using digital or traditional tools, the 2D ink-and-paint characters are placed on or within "background" paintings, which often comprise multiple layers or "planes." Using a "multiplane" camera, the director can zoom in and out through these layers to create an illusion of depth, and the camera can also pan from side to side. For *Tarzan*, that wasn't enough. "Multiplane cameras can't turn corners," says Kevin Lima, co-director of the film with Chris Buck. "We wanted a camera that would follow a roller coaster ride." That implied a 3D solution.

All images © Edgar Rice Burroughs, Inc. and Disney Enterprises, Inc.

By creating a 3D background, Disney's artists made it possible for Tarzan's directors to take the camera into the trees.

Indeed, a few 2D-animated films have used 3D sets for scenes that called for a live-action type of camera movement—the ballroom scene in Disney's *Beauty and the Beast,* for instance. But *Tarzan's* directors believe these 3D scenes typically have a look that distinguishes them. "We didn't want a sequence that would say 'Wow, this is CG,'" says Buck "If [the 3D set] couldn't interact with the 2D painted backgrounds in a seamless way, we didn't want it." Adds St. Pierre, "We wanted people to think they're looking at a 2D painting but then all of a sudden, the camera goes inside the painting, turns a corner and then turns another corner." The directors got what they wanted and more with a new rendering technique dubbed Deep Canvas, developed at Disney specifically for *Tarzan.* Deep Canvas not only gives 3D sets a painterly look, the paintings can be animated so that, for example, when Tarzan looks down at the painted landscape beneath him, a slight breeze can, unexpectedly, ruffle the leaves in the trees below.

The task of creating software that would give 3D renderings a painterly look fell to Eric Daniels, CGI lead and artistic supervisor of digital production for Tarzan. The idea that resulted in Deep Canvas is simple, although creating the software was not. "I'm glad I didn't know how difficult a job it would be," says Daniels, who realized, after talking with several department heads, that the software not only needed to integrate 3D and 2D, it needed to fit into the traditional Disney animation production pipeline.

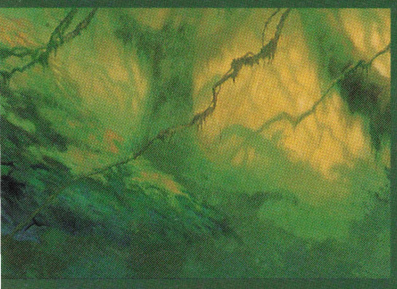
Thus, with Deep Canvas, which was developed largely by Tasso Lappas and George Katanics, background artists paint on 2D plots of 3D scenes, using an adaptation of an in-house painting tool designed for traditional painters. As they paint, information about each brush stroke—its color, shape, the pressure used to create it, and so forth—is stored as data (not as pixels) so that the Deep Canvas software can apply the brush strokes to an appropriate position in 3D space. "It's as if the brush strokes fly back in space and land on whatever surface the painter intended," Daniels explains.

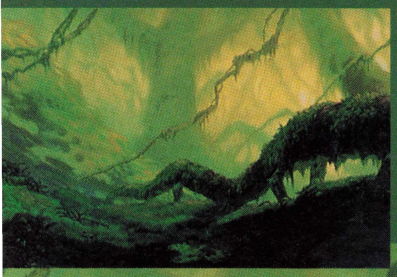
For example, a sphere might represent an area with a canopy of leaves. The painters paint the leaves in whatever style they choose, and as they do so, information about each brush stroke is stored. "When a frame with this canopy is rendered, the sphere goes away but the brush strokes land in mid-air and stay," Daniels says. "The computer plays back every brush stroke in every frame and if the object changes shape [because the camera moves], the brush strokes can follow." What the painters work with are plots of high-resolution, fairly detailed

NEW TECHNOLOGY HELPS A 2D TARZAN SWING THROUGH A 3D JUNGLE

Fitting Tarzan into the scene required a painterly rendering for the 3D models.

models. Their brush strokes, however, are actually applied to large surfaces lofted from the high-resolution model. If their brush strokes were applied to the finely detailed model, any that went off the model would be clipped when the frame was rendered, thus producing a hard edge. Because the brush strokes are applied to the large surface instead, the painters don't have to stay in the lines, and the scene is rendered with a more painterly look. Areas not painted are rendered transparently. If a camera moves to an unpainted area of an object—the back side, for example—the layout department provides a new plot so that the background painters can fill in unpainted areas. Frames are rendered at 2048 resolution.





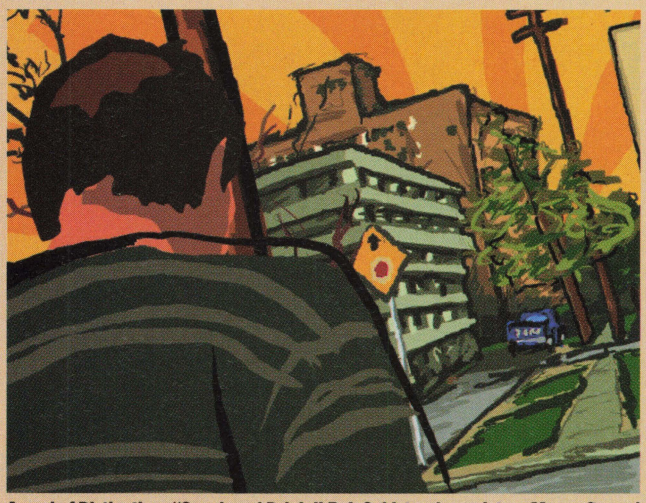
To create these 3D Deep Canvas backgrounds, Disney developed a new "brush-stroke" rendering technique. "We wanted it to be impossible to tell a rendered still from a painting," says Eric Daniels, CGI lead.

The idea—of rendering brush strokes—didn't originate with Daniel's group. Barbara J. Meier, for example, wrote a paper, "Painterly Rendering for Animation," which was published in the SIGGRAPH '96 Proceedings, in which she described a brush-stroke rendering technique developed while she was a technical art director at Disney Feature Animation. "If it weren't for Barb Meier, we wouldn't have done Deep Canvas," Daniels says. "She proved it could be done. But her focus was on automation. For *Tarzan*, we wanted artistic control."

That control begins with the layout group. Because this group traditionally draws the elements to be painted by the background department and plans the camera moves, it was appropriate for layout artists to create 3D models for Deep Canvas scenes and provide the the 2D plots based on the camera moves. To prepare this group for Deep Canvas, Disney sent 25 artists to the Digital Media Institute (now defunct) for training under Gil Zimmerman, who eventually joined Disney and became Model Department Supervisor. "They got a crash course in Alias Power Animator, Unix, and email," he says. "Of the 25 artists, 25% had never touched a computer, so I wasn't teaching them how to push and pull CVs; I was teaching them how to use a mouse and what it means to save a file." Zimmerman stayed with the layout department through the production, helping them create the models, the 3D environments, several props, and also effects such as water. The group used Side Effects Software's Houdini and Alias|Wavefront's Power Animator and Maya software, all running on SGI workstations, with Houdini largely used for "troublesome scenes," according to Zimmerman, and Power Animator for the models.

All told, Disney used Deep Canvas for a total of about 10 minutes, sprinkled throughout slightly more than 10% of the film. If you can't pinpoint the transition from painted backgrounds to Deep Canvas, the directors will be delighted. For his part, Daniels is already looking toward the future. First, he plans to give the software a friendly user interface. Then, who knows. "There's no reason why we couldn't do a Deep Canvas character," he says. "We've barely scratched the surface with what we can do."

Barbara Robertson is West Coast senior editor for Computer Graphics World. *Send email to barbararr@aol.com.*



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Prix Ars Electronica 99

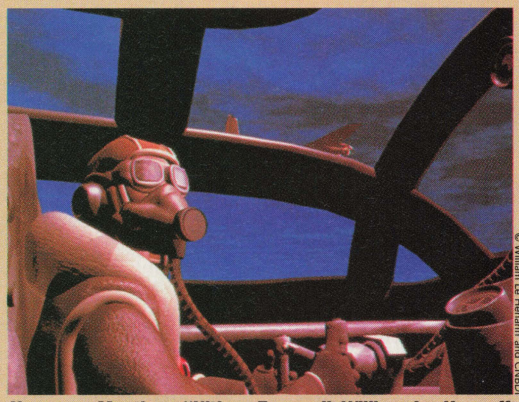
The Prix Ars Electronica competition, held for the 13th time by the Austrian Broadcasting Company's Upper Austrian Regional Studio, has announced winners in its Computer Animation and Visual Effects categories. The competition was juried in Linz, Austria, in May, when nearly 300 entrants competed for top honors and $50,000 in prize money, which will be awarded this fall.

The grand prize for computer animation, the Golden Nica—and some $17,000 in cash—will be awarded to Chris Wedge of Blue Sky Studios (Harrison, NY) for the short film "Bunny" (see *CGW* February 1999, pg. 23). The film showcases the studio's proprietary rendering techniques. The Golden Nica gives "Bunny," which earlier this year won an Oscar and the top prize at Imagina, an animation "triple crown." Awards of Distinction in computer animation, with prizes of more than $4300 each, will be awarded to John Lasseter and Andrew Stanton of Pixar (Pt. Richmond, CA) for the Disney/Pixar film, *A Bug's Life* (see *CGW* November 1998, pg. 24), and to a short animation titled "Snack and Drink" by Bob Sabiston (Austin, TX). In addition, 12 entries received Honorary Mentions.

In visual effects, the Golden Nica will be awarded to the studios—Digital Domain, Mass Illusion, POP, and others—that created the effects for the movie *What Dreams May Come.* Two Awards of Distinction will be given to the Computer Film Company (London) for its work on the Guinness "Surfer" commercial and to Alain Escalle of Trix (Paris) for the short film "A Viagem."

These prizes will be awarded on September 6 during the Ars Electronica festival in Linz. Following the festival, the exhibition will be on tour for a year, courtesy of Siemens. To view all the winners, visit http://prixars.orf.at/.

—Barbara Robertson



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Honorary Mention: "Ultima Forsan," William Le Henanff (Softimage 3D, Power Animator)

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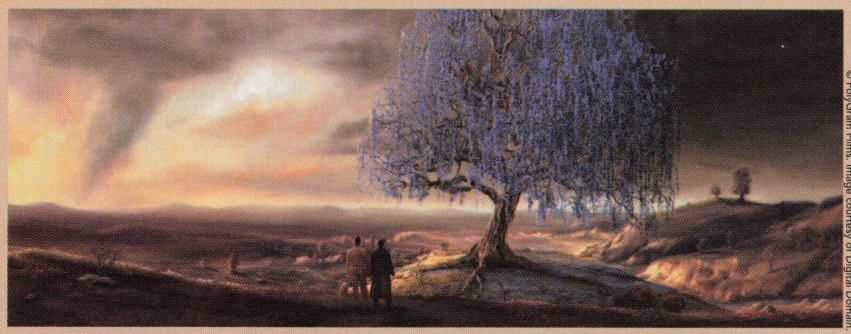
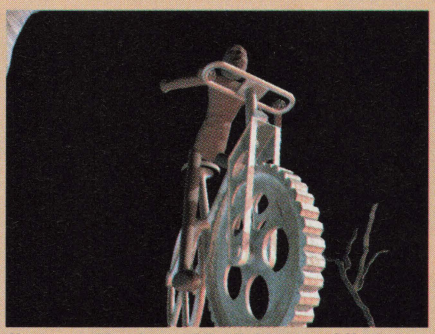
Honorary Mention: "Bad Night," Emre Yilmaz (ALIVE, Photoshop)

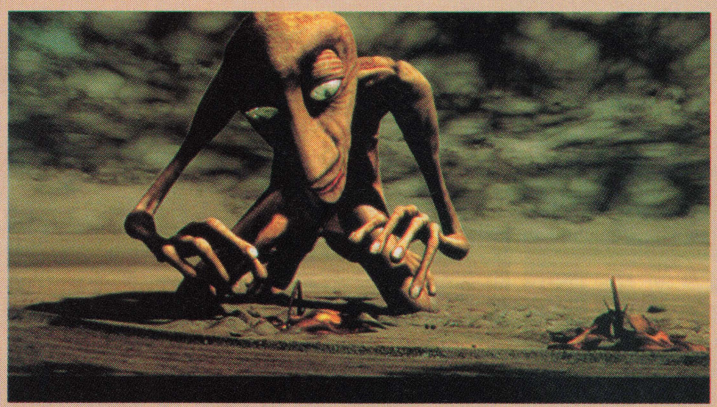


© PolyGram Films. Image courtesy of Digital Domain

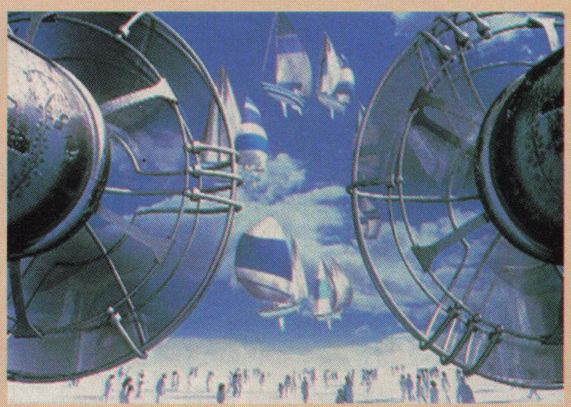
Golden Nica: "What Dreams May Come," PolyGram Films/Interscope (multiple software programs)



Honorary Mention: "Bike," Dietmar Offenhuber (Softimage 3D, Maya)

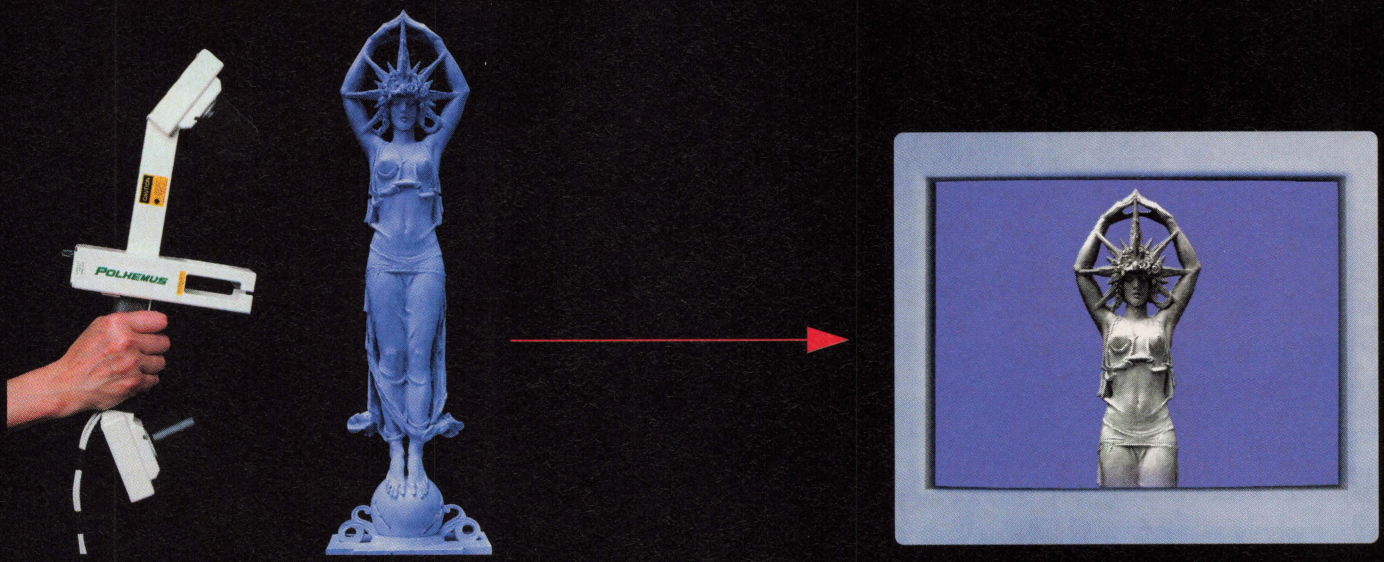


Honorary Mention: "Stationen," Christian Sawade-Meyer (3D Studio Max, 4D Paint, Premiere, Photoshop, After Effects)



Honorary Mention: "Lottery Fantasy," Manu Horrillo, Daiquiri/ Spainbox (Discrete applications, Softimage 3D, Power Animator, Maya)

Award of Distinction: "Guinness Surfer," Ruth Greenberg, et al, Computer Film Co. (Cineon, Houdini, Renderman, Maya, Keylight)



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CAD/CAM/CAE

A Driving Ambition

CAD technology helps a group of students from a small college stay in the race

BY KAREN MOLTENBREY

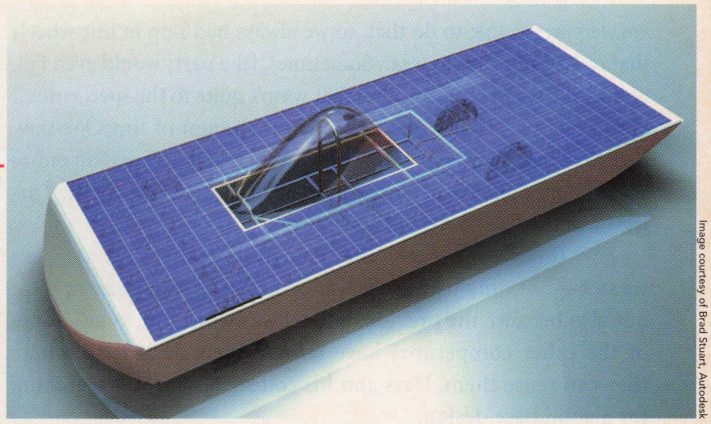

Image courtesy of Brad Stuart, Autodesk

Using CAD technology to design its solar car entry for Sunrayce '99 enabled the team from Principia College to dramatically cut manufacturing time of its vehicle.

This summer, a diverse group of students from a small Midwestern college will be pitted against peers from some of the biggest universities in the country during a 10-day race through six states in a custom-engineered solar car designed and built by the young scholars. Even before the competition begins, the odds are against the 15-member team from Principia College in Elsah, Illinois, a school with a student enrollment of 550—and no engineering department. But the group is not ready to throw in the towel just yet. It is hoping that by using CAD technology to design and manufacture its entry, Ra^3, it can level the playing field somewhat in this competition of innovative engineering.

"It's a triumph of ingenuity that we're able to participate; we're the only nonengineering school that competes," says sophomore Jonathan Hess, co-leader for the Principia team. "We don't have an engineering background, so a lot of this project is done initially as guesswork, and then we turn to experts to check it out. So the fact that we're even able to build a working car is something of a miracle. It requires a lot more creativity than saying to a mechanical engineer or engineering student, 'We need a front suspension design,' and that person designs it based on what's been done before and what'll work. Our team consists of computer science and physics majors, plus philosophy majors and several undeclareds."

At Principia, the project is an interdisciplinary effort, most closely affiliated with the physics department, which resulted in a dearth of available on-site expertise and tools. "Our school doesn't have the investment in computer-aided design software or hardware that big schools, like MIT or Caltech, have," Hess explains. That was one of the reasons why the group chose Autodesk's (San Rafael, CA) Mechanical Desktop for its CAD package. "It had the functionality of the bigger packages, was easy to learn, and it ran on our existing [Windows NT-based] Pentiums," he says.

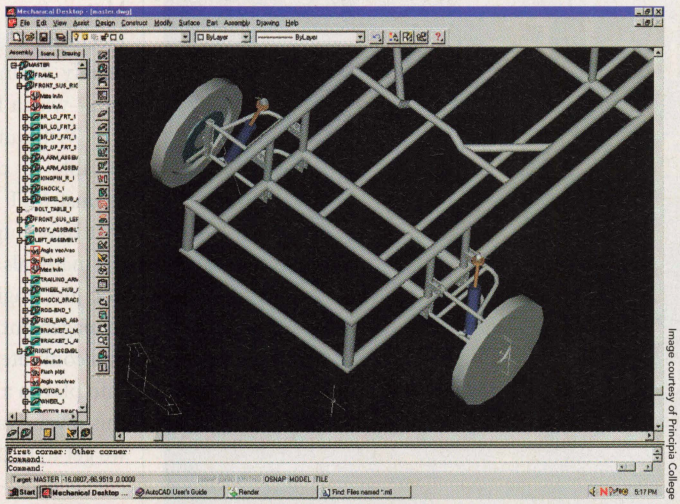

Image courtesy of Principia College

The Principia team used Autodesk's Mechanical Desktop CAD software to design the car's frame, a tubular steel structure similar to that of a go-cart.

Can CAD make a difference? Hess certainly hopes so. The school has participated in the past two races, held every two years, but has not finished high in the standings. In the 1997 race, the team came in 31st in a field of 40, which wasn't bad for a college that spends a fraction of the money on its entry compared to the other schools. "But that car was built entirely without using CAD software," Hess points out. "Those [earlier entries] were kind of like backyard projects, where we put them together, drilled holes, determined if the pieces fit together, and re-drilled them if they didn't. We called it our three-step design process: Build it, fix it, and rebuild it because you can't fix it anymore," he jokes. "It was a very imprecise process, and as a result, the final car looked rather sloppy and didn't run effectively because we couldn't communicate our design well."

That methodology also created another obstacle: The group was unable to outsource any part of the fabrication process because it could not generate engineering drawings. "Using professional CAD software has enabled us to treat this work as it should be—a true engineering project," Hess says. "We can design parts in solids, and review designs before anything is built. Mechanical Desktop has taken us way beyond our last team's engineering environment."

New and Improved

What a difference those two years have made. According to Hess, the group has used Mechanical Desktop to output 2D drawings "to the point where the entirety of our car has been output to 2D." This has resulted in a huge time savings and higher quality parts. For instance, in the past, the team has built its own car hubs (the part that attaches the wheel to the axle). To do it properly, however, requires machining the parts to tolerances within a thousandth of an inch.

"Being amateur machinists,

we were never able to do that, so we always had slop in our wheels that caused our tires to wear. Sometimes, [the part] would even fail, and we'd have to build another that wasn't quite to the spec, either," Hess explains. "That took a tremendous amount of time. We only had 15 members on our team, so we were trying to build an entire car in about one year, because almost all of the first year [of the project] was used solely for the design work."

For this year's race, the Principia team started from scratch—not only because it was armed with a 3D design tool, but also because the previous model was worn out. While some of the other competitors have refined their designs to where they can reuse them, Hess and his colleagues are still searching for a good base design.

During the fall of 1997, the group began using Mechanical Desktop to design the car's frame and front and rear suspensions. Because the group could load this assembly—comprising about 200 to 300 parts—in its entirety into the software program, it was able to ensure that all the parts fit together without interference.

Mechanical Desktop also proved its mettle in designing an entry/exit for the vehicle's driver. The regulations dictate that the driver must be able to exit the car within 10 seconds, which created a dilemma: How do you maximize the solar array area of the solar-powered vehicle without requiring the driver to step on the extremely fragile solar cells. "Being able to draw it in Mechanical Desktop and render it has enabled us to see what space we have in the cockpit, how a person could fit, and if it would be possible to climb out through the canopy or whether we needed to hinge the whole body," says Hess.

Additionally, the software's parametric dimensioning feature proved helpful when changing and tweaking the chassis, body, and suspension designs. In the course of designing the body, the group had to determine where to place solar cells on the vehicle's roof. Because the cells vary in size, each design layout differed, depending on the cells used. "When we finally made a decision, the updated geometry feature provided us with a final drawing, without having to entirely redraw the body."

This year's vehicle is as complex mechanically as a standard automobile, according to Hess. "In fact, because of its unique solar-power requirements, we are dealing with design issues that even bigger car manufacturers do not have to deal with," he says. "We have to design a car that is light and efficient due to the limited power," which resulted in a front and rear suspension system comprising 50 to 60 parts.

A Race Against Time

In all, Hess estimates that the group was able to cut its design and manufacturing time for Ra^3 from months to weeks—all because of using CAD technology. Specifically, the members cut the building time for the project by a third, since they were able to build Ra^3's parts concurrently using Mechanical Desktop (whereas before, this was done sequentially to ensure that they would fit) and could outsource some of the work, as is permitted in the rules. Because the group could provide working drawings, it was able to enlist help from an engineer at Structural Analysis in Austin, Texas, who performed finite-element analysis on the chassis design—which led to a redesign based on those results.

Because of the private donations the team has received in software, materials, and funds, Hess believes Principia College will be a contender in Sunrayce '99, a 1300-mile course from Washington, D.C., to Orlando, Florida. To narrow the list of competitors to 40, the teams must pass rigorous inspections by General Motors (one of the race sponsors, along with Electronic Data Systems in Plano, Texas) and qualify during a test run in Milford, Michigan—which Hess and his colleagues did.

"Without these donations, we would not be able to compete in a race of this scale against MIT or one of the other big schools that have huge budgets and can purchase all the materials they need," says Hess. "For us, it's not just engineering skills; it's also project-management, presentation, communication, and computer skills—all the factors that come into play in a real-world job situation, making this a very valuable learning experience. And we get to build the car."

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GAMING

A Slave to Technology

Development of a new game propels *Slave Zero* to the cutting edge

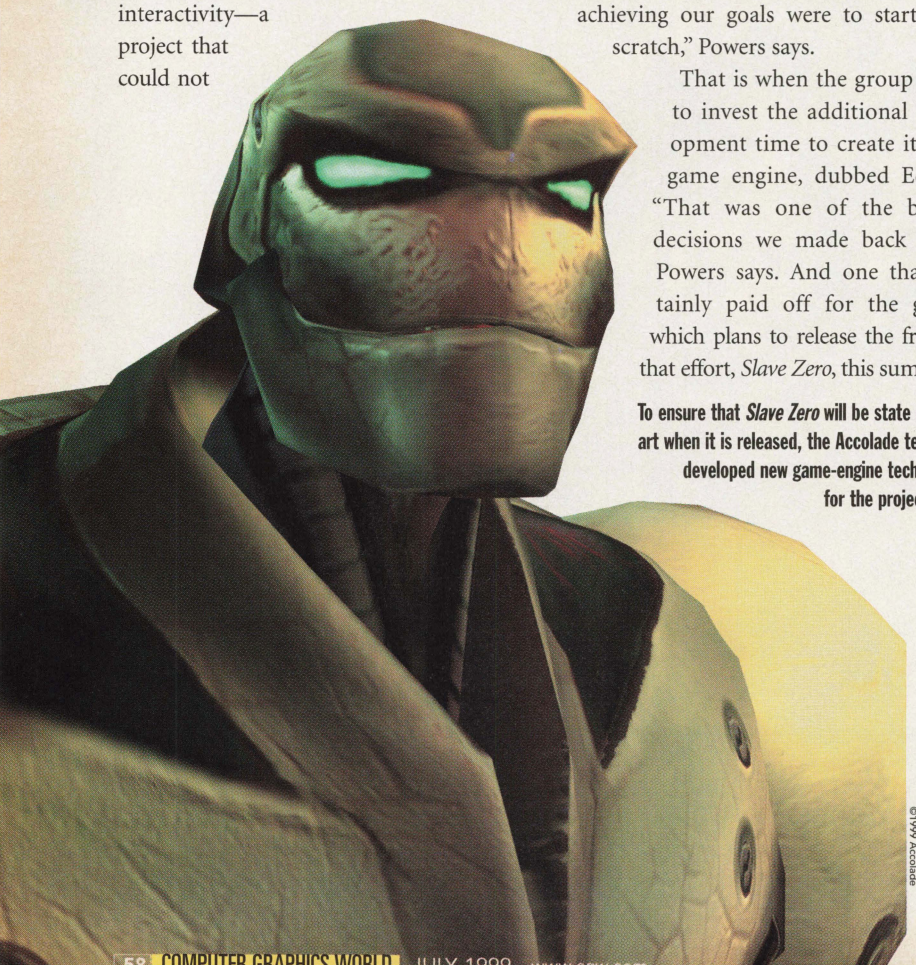
BY KAREN MOLTENBREY

When a group of developers at Accolade, a San Jose, California, video game maker, decided to create a new PC action game, they took an approach that was exceedingly ambitious. Their goal was to deliver a cutting-edge game with large, well-lit, detailed environments filled with animated objects and one that offered plenty of interactivity—a project that could not be accomplished on an overnight basis.

The first step the group took was to find a 3D game engine that could fulfill the group's aspirations. "We wanted to be extremely aggressive in our graphics, animation, and game play," says Matt Powers, producer. "From a graphics standpoint, we wanted to have a lot of lighting, both dynamic and static, and a world that seemed extremely alive. We wanted to make sure that when we released the game—we knew it would take about two years to complete—it looked, played, and performed state of the art."

However, the developers came up empty in their search. "We felt that the existing technology, although at that time was very advanced, wouldn't be able to deliver on those basic concepts a year or so down the road. So we thought our best odds for achieving our goals were to start from scratch," Powers says.

That is when the group opted to invest the additional development time to create its own game engine, dubbed Ecstasy. "That was one of the biggest decisions we made back then," Powers says. And one that certainly paid off for the group, which plans to release the fruits of that effort, *Slave Zero*, this summer.



To ensure that *Slave Zero* will be state of the art when it is released, the Accolade team developed new game-engine technology for the project.

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In *Slave Zero*, the player is transported 500 years into the future to S1-9, an enormous, grungy city overflowing with millions of people, automobiles, and aircraft, where the evil dictator SovKahn uses a mysterious energy source and scores of towering sentinel robots to secure his rule. A rebellion ensues, during which the player steals the secret technology, perfects it, and fuses it into one of these robotic beasts—creating the first such biomechanical creature, Slave Zero. The player then physically and mentally bonds with the slave, becoming something not quite human, not quite machine.

As Slave Zero, the player sets out on a mission to destroy SovKahn and restore peace, smashing through the city and engaging in combat with a variety of the dictator's sentinels—from human-sized troops and tanks to 100-foot armed behemoths of steel—and battling with SovKahn's own slave creations.

A Different Perspective

Slave Zero is played from a third-person perspective, with an emphasis placed on scale and interactivity: Towering buildings line the busy streets filled with moving cars, trucks, and buses; airplanes whiz overhead; and people race down sidewalks screaming in fear. Although 60 feet tall, Slave Zero can agilely move throughout this environment, running down the highway, jumping and climbing atop buildings, picking up cars and hurling them at enemy troops, even grabbing onto buildings to hoist itself up.

All this movement and animation appears on the screen, which would not have been the case if the developers used the typical first-person gaming perspective, in which the player only sees the action from the main character's viewpoint (so the full-body Slave Zero would not have appeared).

"The first thing people notice is our basic concept. In summary, it's a giant-robot action game, and no one has tried one like this before," says Powers, noting that most giant-robot games are simulation-like and slower-paced. If we would have created this from the typical first-person viewpoint, he adds, the game's sense of scale would have been diminished, and the character's animation would have appeared less fluid.

"Our whole point was to create a very

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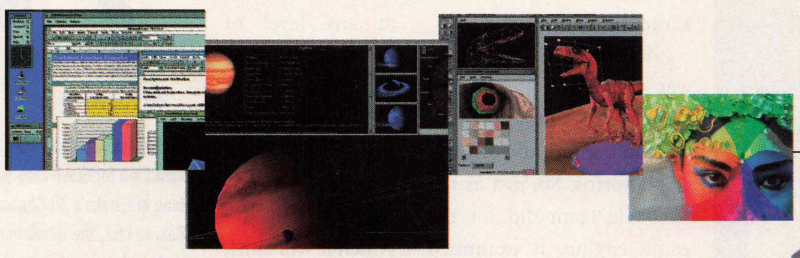

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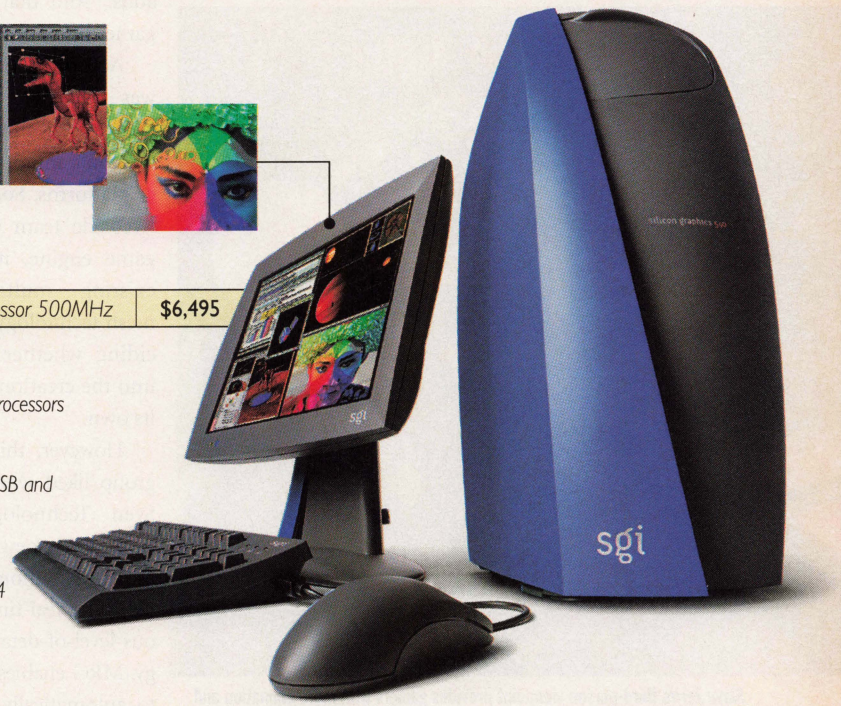

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agile, almost human-like giant robot. He moves slowly, yet with agility, and has these long, agile fingers that are always twitching, so he really looks and feels as if he's alive," says Ken Capelli, lead artist on the project.

Maximizing Max

Another important choice the group made concerned the project's development environment. Almost the entire project—including the modeling and animation (all keyframed)—was accomplished using Kinetix's (San Francisco) 3D Studio Max running on Pentium IIs. The animators also used Max to place the lighting. But to achieve the game's extensive lighting effects—including precalculated lighting for realistic shadows, and real-time lighting resulting from various actions, such as explosions—the group utilized the new game-engine technology.

Additionally, the artists and designers used Max to script the events, paths, and enemy placement, which required them to write a number of plug-ins. For instance, the group used a proprietary plug-in to export data from 3D Studio Max to a format recognized by the game engine. This script also provided some capabilities not achievable in Max that, in effect, turned the Kinetix software into a game tool.

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***Slave Zero*'s third-person viewpoint provides gamers with more animation and conveys the game's unique sense of scale.**

"The Ecstasy engine includes our tool set. A big part of that is our extensive plug-in to Max," Powers says. "Max was important, but we couldn't have done this project without the engine. Without the plug-in and code, we couldn't have used Max almost exclusively." In fact, the only other off-the-shelf software used was MetaCreations' (Carpenteria, CA) Painter 3D to paint and texture the objects and models.

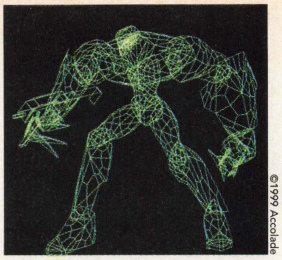
Using the game engine's customized technology enabled the group to use 3D Studio Max to populate the scenes with huge amounts of objects and animations—from small objects, like cars and people scurrying about, to large objects, like buildings that collapse and trains that race by. But creating a dynamic, living, interactive environment while keeping the game's action and pacing at a high level was particularly challenging.

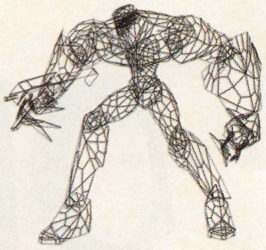
"We were constantly struggling with putting more items into the scenes to reinforce the sense of scale and putting in more enemies and weapon effects, and bigger weapons, without taxing the frame rate," Powers adds. "And that's what the game engine delivered."

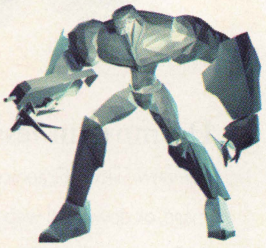
According to Powers, it was important that Accolade's new technology function on a multitude of player platforms. So, just as the Accolade team did for the game engine, it examined existing multi-resolution mesh technology before deciding whether to launch into the creation process on its own.

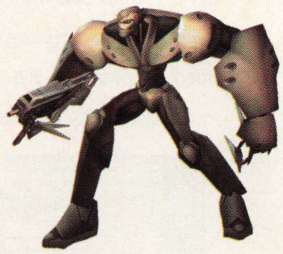
However, this time, the group liked what it saw in Sven Technologies' (Palo Alto, CA) newly released Multi-Resolution Geometry (MRG), a real-time, continuous-level-of-detail technology. MRG enables 3D objects to automatically and seamlessly gain and lose resolution—without "popping"—depending on their proximity to the viewer and other parameters set by the game developer. Popping occurs when models of varying polygonal counts are noticeably swapped in and out.

Slave Zero is one of the first projects to use the MRG technology. By incorporating MRG into its Ecstasy engine, the Accolade group can maintain *Slave Zero*'s visual quality on lower-end PCs without creating multiple representations of the same object (in higher- and lower-resolutions). Instead, artists can create a high-resolution 3D model and run it through the MRG processor (part of the tool set and embedded into the engine), allowing them to render the object at any level of detail during runtime.









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All the character modeling and animation for Slave Zero was done in Kinetix's 3D Studio Max. In fact, the developers wrote extensive plug-ins that enabled them to use the software as a game tool.

"When creating games, you choose a minimum system [on which it will run], so it can run well on a slower machine, if you reduce your graphics quality or take [objects and movement] out," Powers says. "MRG lets us keep a large number of characters and animation on the screen, so lower-end users can run the game as we envision it." *Slave Zero* requires a minimum of a (200MHz) Pentium and a 3D graphics accelerator.

Using the MRG technology will enable the group to easily port the graphics to another gaming platform with different resolution requirements. In fact, this fall, a Sega Dreamcast version of *Slave Zero* is planned for release.

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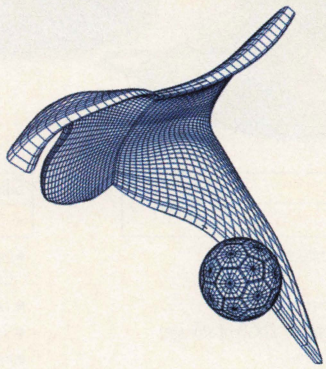
BROADCAST

GRAPHICS SCORE AN INTERNATIONAL GOAL

Animators turn the Budweiser beer logo into a world-class soccer player

BY KAREN MOLTENBREY

©Anheuser-Busch. Images courtesy of Little Fluffy Clouds



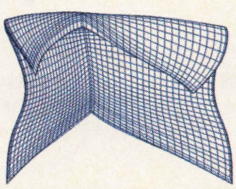
While the Budweiser Logo's movement and the background lighting effects and grass appear realistic in the commercial, the audience appears impressionistic, so as not to compete with the logo soccer star.

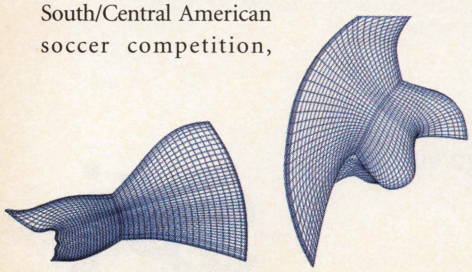
How do you turn a 2D bow tie-shaped logo into a master soccer player who mesmerizes fans with his dexterity? For Jerry van de Beek and Betsy de Fries, owners of the San Francisco design and animation boutique Little Fluffy Clouds, the answer was simple: Spend many hours using deformation tools to achieve a fluid, realistic motion—and know a lot about the sport of soccer.

In fact, van de Beek notes that the ad agency for the commercial, DDB Needham in Chicago, was looking particularly for a director who knew a thing or two about soccer, and he fit the bill, growing up as an amateur player and fan in Europe. "Jerry is a soccer fan and knows the intricacies and the nuances of the game. When the logo runs, it looks like a player—you can actually see the knees bend. He gave the character personality and really brought him to life," says DDB Needham's Karim Bartoletti.

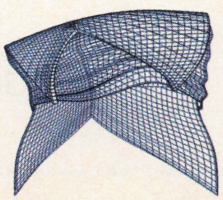
This intimate knowledge of the sport was paramount, as the moves of the character and the soccer play in which he engages had to be authentic in every degree. That's because the 30-second Budweiser spot, called "Logoal!," was made specifically to air internationally during Copa America 99, the ultimate South/Central American soccer competition, hosted this year in Paraguay and running through the end of July.

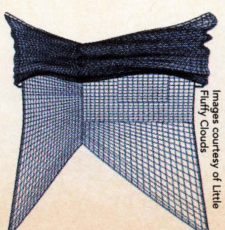
Of equal importance, says de Fries, was that the commercial truly represent the participating countries in the match. "Our concept was to intertwine the animation and motion for this piece with the rhythms of South and Central American music, accompanied by actual sound effects from a South American football match," she explains. "Plus there are a lot of little things that true South/Central American soccer players would pick up on," such as the dance-like movement of the character and his number, 9, fashioned to represent the famous Brazilian-born soccer player Ronaldo.





To transform the Budweiser logo into a masterful soccer player, Jerry van de Beek spent about 10 weeks modeling and animating the 2D image in Softimage. Achieving all the fluid motion involved an extensive amount of keyframing animation.

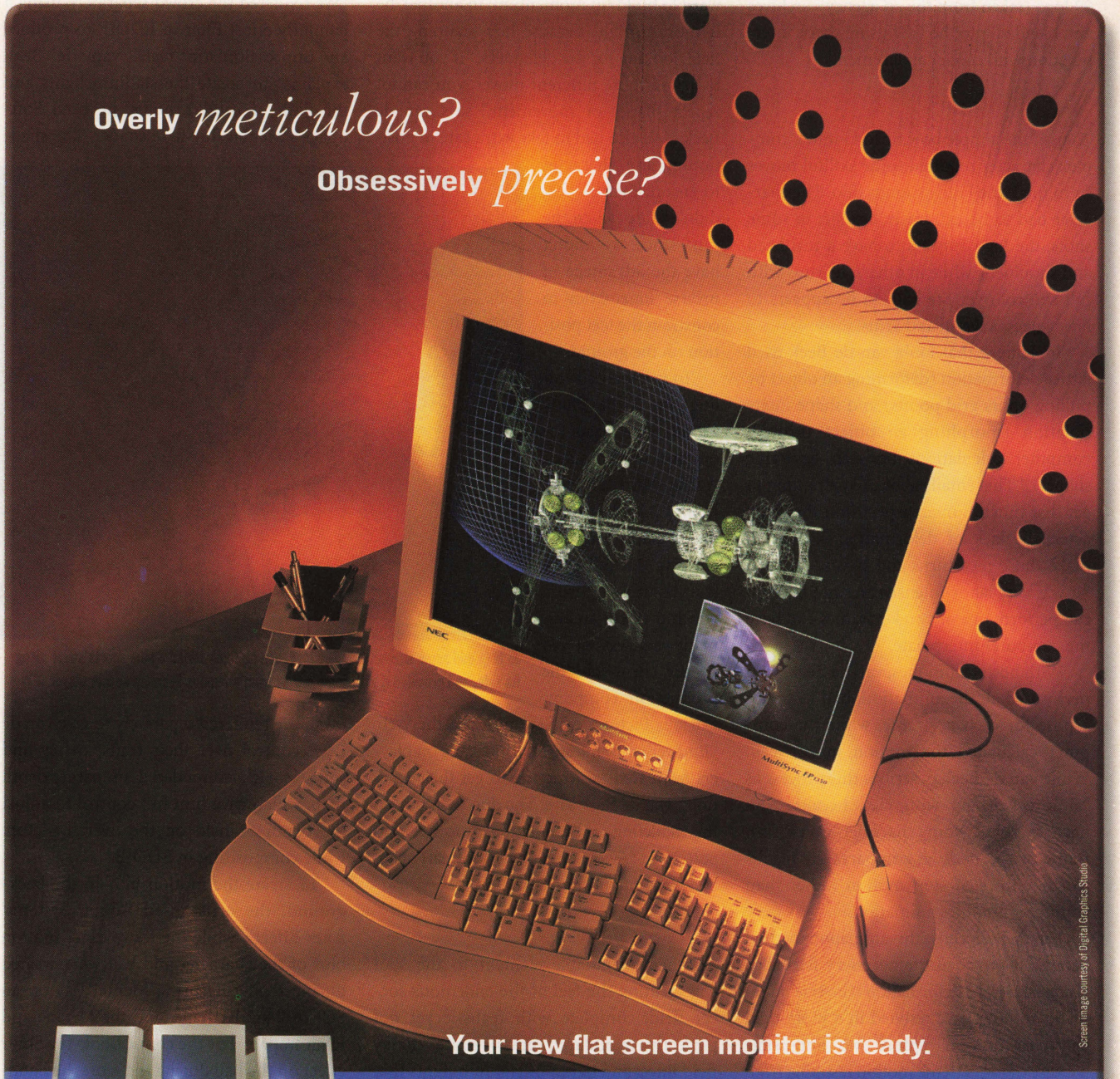




Images courtesy of Little Fluffy Clouds

"Logoal!" opens on the classic Budweiser bow tie logo, with the action seen from the point of view of two opposing players. The first opponent pursues the logo character with slow, cat-like moves, but is outmaneuvered by Logoal's fancy footwork and masterful moves. The logo then flashes past the second defender to score. In a jubilant victory run around the arena, the character races toward the camera and, in the scoring style of South American soccer, lifts his jersey to reveal a message that is closest to his heart.

However, instead of the hand-written notes typically fashioned by these soccer players—such as the Hispanic version of "I love you Mom"—Logoal's message is quite different: live-action footage of beer overflow-



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ing a glass with a prominent Copa American 99 logo (taken from the ad agency's archives and blended into the CGI using shape interpolation with model replacement).

Smooth Moves

To turn the simple bow tie logo into a complex character required some skillful moves from the Little Fluffy Clouds duo. The character had to be extremely flexible; in some shots, the logo appears to have a real head and shoulders, while in others, he runs with full control over the ball, so he appears to have knees, a waist, and arms.

To achieve that look, van de Beek used lattice deformation (deforming an object by pulling on its grid points) and shape interpolation (morphing an object through computer calculations between keyframe shapes). "This entails a lot of keyframing to get that much human aspect into the character; the lack of deformation is used to make those nice turns and twists," he says. "It was very labor-intensive; it's not like you can perform one or two keyframes and have the computer interpolate."

With both techniques, van de Beek, who performed all the animation, had to sculpt a pose for each keyframe, while the computer calculated the motion in between. While van de Beek describes this process as "almost working with clay, because you have to shape your character every fifth frame or so," de Fries compares the results to "the ethics of stop motion rather than computer graphics animation."

Van de Beek chose this animation method because it provided the necessary flexibility. Using skeleton deformation (inverse kinematics) would have resulted in a more rigid character; motion capture was impossible because of the extreme motion resulting from the character's dimensions.

"If you use skeleton deformation, you work with rigid joints; the character's elbows are always at the same place. With the logo, I didn't want that, because I wanted to emphasize [not just portray] various body portions—head, shoulders, knees—depending on his movements," he says. "Sometimes the waist was more important; in other shots, the head and shoulders were more important, like when he's bobbing the ball with his head."

Although the commercial contains three shots in which Logoal is running, each run cycle was created separately, so each looks different from the others. For instance, in one segment, the character is leaning forward to build up momentum; in another, he is more upright because he's scanning the field, looking for the defenders. "If you want to get all those different moves, you cannot repeat shapes or movement," says van de Beek. "We also had to take extra care in positioning the character to ensure that his feet didn't slide when he ran, since we didn't have the advantage of inverse kinematics to constrain the feet position on the ground."

To get the ball rolling, the Little Fluffy Clouds team began the design work, using Adobe Systems' (San Jose, CA) Photoshop on Macintoshes for creating 35 full-color storyboards, from which they cut an animatic that was viewed by the client and the production company, Curious Pictures of New York, via the Web. "Budweiser even tested the animatic on players from Central America, to get their reaction," van de Beek says. The duo then moved the modeling and animation processes into Softimage (Avid, Softimage; Montreal) on an SGI (Mountain View, CA) Octane.

©Anheuser-Busch. Images courtesy of Little Fluffy Clouds

To help add some character to the logo, van de Beek added a blue sports stripe along its side, and provided it with some moves from a famous Brazilian soccer player.

Stadium View

Another formidable element to the spot was creating the feel of the enormous soccer field, complete with realistic yet not perfectly manicured grass, white chalky field lines, and banks of stadium lights that cast realistic shadows onto the playing area. To achieve that look, van de Beek craftily used depth-of-field techniques (because the camera is one of the players, it gives the impression that the field is quite big) and rendering, splitting the process into as many as 10 layers, which were composited using Softimage's EDDIE Compositor on an SGI High Impact. "This gave us more control in adjusting the color, depth of field, shadows, light effects, and blur motion," he says.

The first challenge in this procedure was creating the crowd, which the artist wanted to be fully animated but not distracting from the action of the logo and the ball. "We rendered the crowd separately, using a painterly effect filter in EDDIE to produce an impressionistic feel," van de Beek explains. To create the stadium lights and the flash of camera bulbs, he used Softimage's Mental Ray flare shader. The shadows were rendered separately to give van de Beek control over their transparency and softness. He also rendered a separate depth map, which gave him full control to adjust the depth of field on the overall picture while compositing in EDDIE.

To create the motion blur in the background, the artist used Adobe Systems' After Effects, while the more exact motion blur of the character and ball were created during rendering using Mental Ray on an SGI Indigo2 Extreme, and the Octane and High Impact. For the comic book-type blur effect on the ball during the score, he hand-painted the effect in Photoshop.

Perhaps the most formidable challenge of all, according to van de Beek, was putting the heart of the sport into a 30-second spot. To train for this event, the Little Fluffy Clouds duo watched hours of footage from major matches and viewed pages of soccer articles until they memorized all the right moves. "We knew most of them," de Fries says. "We're big fans; all work here came to a grinding halt during the World Cup tournament."

Key Tool **Softimage**, Softimage/Avid (www.softimage.com) **infoNOW 122**

thinkdesign

think3's new CAD program bucks convention

BY JEFFREY ROWE

thinkdesign is a highly intuitive Windows-based 3D design program that offers strong drafting, wireframe, solid modeling, and surfacing tools that can be used anywhere in the design process.

Although think3 announced thinkdesign early this spring, the product has been around since 1997, when it was known as Eureka Gold from Cad.Lab. Today, think3 is aiming thinkdesign at the more than 3 million 2D MCAD users who, the company says, want to make the transition from 2D to 3D but haven't because 3D software is typically expensive and difficult to learn. It is also targeted at users who want to continue working in 2D but need advanced design tools, and those who want more from their mid-range solid modeling tools.

thinkdesign competes primarily with SolidWorks' SolidWorks 98, Ashlar's Vellum Solids, and Autodesk's Mechanical Desktop. Three main features set it apart from the crowd: its game-based learning technology; its subscription-based pricing model; and its nonmodal paradigm for designing simultaneously in wireframes, solids, and surfaces, with a proprietary modeling kernel.

In an effort to make the product easy to learn, think3 hired Corporate Gameware llc (New York) to create *The Monkey Wrench Conspiracy*, a *Doom*-like 3D video game that quickly teaches users how to design objects in 3D. Overall, I found this approach quite effective. Supplementing and reinforcing the game is thinkdesign's online help system.

To facilitate the use of thinkdesign by 2D designers, the software has an optional compatibility mode, which provides a familiar interface, complete with command line. Users can also quickly create custom command-line aliases for often-used commands.

Under thinkdesign's pricing model, you don't actually purchase a license; you subscribe to it on an annual basis. The price, which includes maintenance, technical support, and basic surfacing tools, is $1995 per year. For an extra $1995 annually, you can purchase thinkshape, an add-on module that offers full surface design capabilities. And another $350 per year gets you thinkreal, a software option for photorealistic rendering.

think3's subscription-based pricing makes the initial cost and subsequent years' pricing attractive when compared to other mid-range CAD packages, for which you pay an up-front price and then have to buy additional maintenance and support that you must renew each year to keep current.

Unlike virtually all its competition, which is based on ACIS or Parasolid modeling kernels, thinkdesign is based on a proprietary modeling kernel, developed and maintained internally by think3. While few other CAD vendors do so anymore, one advantage is that think3 does not have to depend on a third party for the crucial elements of thinkdesign and, therefore is in a better position for actually releasing product updates on time as promised.

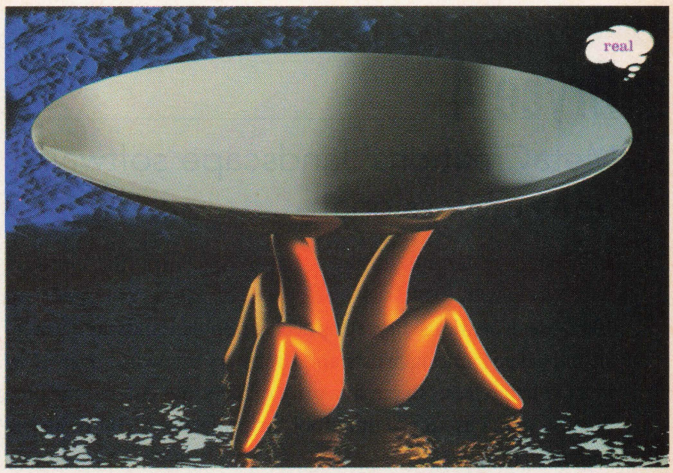
More important, however, this proprietary modeling kernel provides thinkdesign with the ability to handle non-manifold topology. For example, with thinkdesign you can perform surface or solid operations on objects that are not completely closed. In addition to handling non-manifold topology, thinkdesign is nonmodal. This means you can use it in virtually any mode: part, assembly, solid, surface, 2D, or 3D.

One of thinkdesign's few weaknesses is its sheet-metal capabilities, primarily because of the features you cannot specify, such as bend reliefs and louvers. Other drawbacks are that it does not automatically generate structural ribs in a shelled profile; it does not allow you to simultaneously shell and draft a sketch/profile; and when it creates solids directly from surfaces, they are not parametric.

Today, thinkdesign has a somewhat limited range for a CAD product because its strengths are primarily in the conceptual, front end of the product development process. However, the company has announced third-party initiatives that will expand the product's strengths into two main areas: analysis and CAM.

Overall, thinkdesign is a smart, concise, yet comprehensive package.The product is bound to turn some heads and bring some much-needed excitement into what has become a "me-too" parametric, feature-based modeling marketplace.

Jeffrey Rowe is the principal of Cairowest Digital Syndicate, a production and consulting firm. He can be reached at 719-539-8549 or at jrowe@cairowest.com.



Alessi s.p.a., an Italian home furnishings design company, created this fruit bowl using thinkdesign's simultaneous surface and solid capabilities.

thinkdesign

PRICE: $1995 for annual subscription. thinkshape and thinkreal options are an additional $1995 and $350 per year, respectively.

MIN. SYSTEM REQUIREMENTS: Windows 95/98/NT 4.0; Microsoft Internet Explorer 4.01, Pentium processor; 128MB of RAM; 100MB of disk space; 1024x768 resolution.

think3
Santa Clara, CA
888-843-0616
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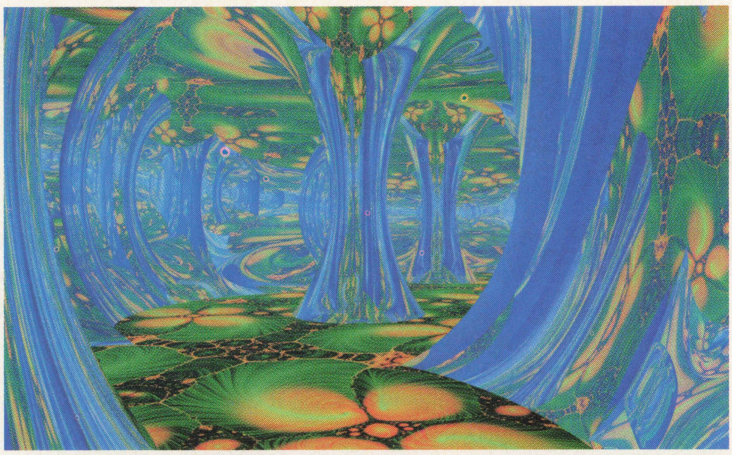
Bryce 4

MetaCreations' landscape software goes professional

BY DOUGLAS A. SAHLIN

Since the product first shipped in 1994, MetaCreations' Bryce has been a popular landscape-generation package among artists and designers the world over. Now in its fourth release, Bryce, at a price of $249, has entered the production arena as an essential tool for professional 3D modelers and animators.



The author created this landscape by applying a pre-set material to one of the new Bryce terrain models. He used the Sky Lab feature to add finishing touches to the scene.

The program is used to create and animate natural and abstract 3D worlds. Graphic designers use it to create scenes, objects, and accessories, while the motion-picture industry uses it for storyboarding and scene generation. Bryce images show up as book and magazine illustrations, on CD covers, and in multimedia and television applications. Bryce also has a loyal following of home computer artists.

New features address creativity, workflow, output, functionality, speed, and the Internet. While these features are more evolutionary than revolutionary, MetaCreations has been resting on its laurels.

Bryce enthusiasts have long hoped for a precise modeling tool within Bryce. Version 4 still doesn't include a conventional modeler. However, it now supports a number of file formats, including .3ds, .t3d, .3mf, .dxf, and .obj. As a result, users can now populate Bryce scenes with 3D models and, where applicable, their associated material files.

Also new is the ability to import United States Geological Survey (USGS) Digital Elevation Maps. Creating a realistic landscape of the Grand Canyon is as simple as downloading the proper DEM file from the USGS GeoData Web site, importing it into Bryce 4, and assigning a pre-set texture to the created terrain. Add one of the pre-set Bryce skies, and render.

Complementing the enhanced import capabilities is the ability to export Bryce terrains to other 3D programs, including Ray Dream Studio, USGS DEM, AutoCAD, Portable Grayscale Map, VRML1, Heightfield, Infini-D, LightWave, Wavefront, and MetaStream.

An important new feature is Sky Lab, which allows users to precisely control all facets of sky generation. It's possible to generate rainbows, star fields, comets, spherical clouds, and fog banks as well as to precisely place the sun or moon into sky scenes. Users can also animate their skies by simply manipulating the Sky Lab's animation timeline.

In the area of landscape generation, Bryce 4's Terrain Editor boasts a number of enhanced features. Users can randomly generate landscapes by choosing from over 20 new terrain model types. The Terrain Editor now supports Photoshop plug-in filters and ships with a selection of Kai's Power Tools (KPT) 3 filters. Users can also add their own filters.

The Advanced Motion Lab, a carry-over from Bryce 3D (the previous version), allows users to fine-tune every aspect of their animations. New to the Advanced Motion Lab in Bryce 4 is an animation preview and storyboard. A single mouse-click generates a Nano preview of the animation as well as a storyboard that shows each animation frame. This feature alone will save hours of test renders. Also new is the option to export animations in Real Movie format for streaming on the Web.

Real Movie export isn't the only enhanced Bryce 4 Web feature. Designers can also now export Bryce scenes with embedded HTML links. Entire Bryce scenes can be exported in VRML or QTVR format, allowing site viewers to navigate Bryce worlds. Fully textured terrains can also be exported in MetaStream format, enabling site viewers to spin, pan, and zoom over Bryce terrains for a unique 3D experience.

As good as Bryce 4 is, it does have limitations. As mentioned earlier, it lacks a built-in modeling tool, which forces users to rely on other programs or 3D clip art to add objects to Bryce landscapes. In addition, I found it difficult to precisely align objects in a busy scene, and I noticed that a few of the program's new features are not documented in the manual.

These glitches aside, Bryce 4 performs admirably. A novice can get up to speed quickly, and experienced Bryce users will take their art and animations to higher levels, thanks to the program's enhanced features and improved functionality. It's an exceptional piece of software that includes many features not expected in a program in this price range.

Douglas A. Sahlin is a writer, digital artist, and Web site designer living in Central Florida. His email address is das001@earthlink.net.

Bryce 4

PRICE: $249 (upgrade is $99).

MIN. SYSTEM REQUIREMENTS:
Windows 95/98/NT 4.0: Pentium; 32MB of RAM; 75MB of hard-disk space; 16- to 24-bit video.
Mac OS: 7.5.5 or later; 32MB of RAM; 75MB of hard-disk space; 16- to 24-bit video.

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CD-ROM LIBRARIES

STOCK FOOTAGE
WIN/MAC/UNIX Eight additions to the Artbeats Digital Film Library span three categories (backgrounds, effects, and archival) and bring the number of titles in the series to 28. Each title—Liquid Ambience, Water Effects 1&2, Gun Stock, Cloud Chamber, Mayhem, Daring Men and Their Flying Machines, and Early Flight—contains D1 resolution, royalty-free clips sourced from 35mm motion-picture film. The clips are delivered in QuickTime format, encoded with PhotoJPEG at a high-quality setting. Users can purchase individual clips from the company's Web site. (Myrtle Creek, OR; 541-863-4429; www.artbeats.com)
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DESIGN ENGINEERING

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WIN/IRIX From Centric Software, Pivotal Collaborative Virtual Product Development (CVPD) software is a modular scalable product that enables dispersed workgroups to collaboratively conceptualize, prototype, simulate, and design products. According to the company, the product provides a unified interface to all the necessary tools for CVPD, including 3D simulation, CAD/CAM/CAE, PDM, ERP, and knowledge management. The modules include Pivotal Studio, Pivotal Publisher, Pivotal Team, Pivotal Behavior, Pivotal Environment, Pivotal Connector, and Pivotal Viewer. The price was not available at press time. (Los Gatos, CA; 408-395-4537; www.centricsoftware.com)
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GRAPHIC DESIGN
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PLUG-INS AND SHADERS
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WIN Novice 3D game designers can create and combine sound, characters, scenes, animation, and various game scenarios using Human Corp.'s Digital Loca Lite 1.0. The foundation of the software is its 3D modeling and animation suite of tools that provides a self-contained environment for creating 3D characters and scenes, and then animating the creation with just a few steps. The product fully supports Direct3D so that 3D video boards can be used to produce texture mapping, highlights, fog, and various other effects with high-speed and high-quality rendering in real time. The price is $76.95. (Los Altos, CA; 650-567-0007; www.digitalloca.com)
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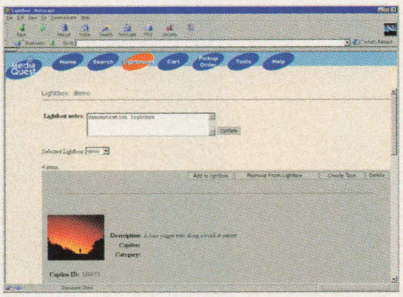
MULTIMEDIA/VIDEO

CONTENT MANAGEMENT
WIN MediaQuest from Picture Network International is a Web-based media-management product that enables



users to control images, artwork, and video clips from a centralized location. Digital assets are loaded, captioned, and cataloged online using either keywords or conversational English to describe each asset. The product's natural-language search technology makes it easy for users to quickly find the desired files without having to utilize complicated search routines. The product features a comprehensive rights-management tool that can be customized. The product's license fees are determined by the number of user accounts. (Arlington, VA; 703-312-6210; www.pniltd.com)
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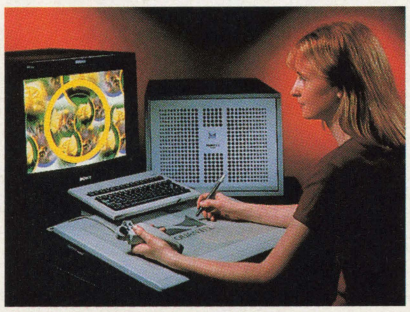
FAT PAINTBOX
UNIX Paintbox FAT from Quantel offers a full animation toolset and 5000 frames of realtime video storage. This version also incorporates



all the basic Paintbox facilities, including custom brushes, 1085 vector-based fonts, 3D perspective, contour picture bending, and transform. Users can keyframe 99 graphic layers, and also splice, stretch, or trim clips. The price starts at $136,000, or at $45,000 for PaintBox Espirit, a version sold without video input and output hardware. (Darien, CT; 203-

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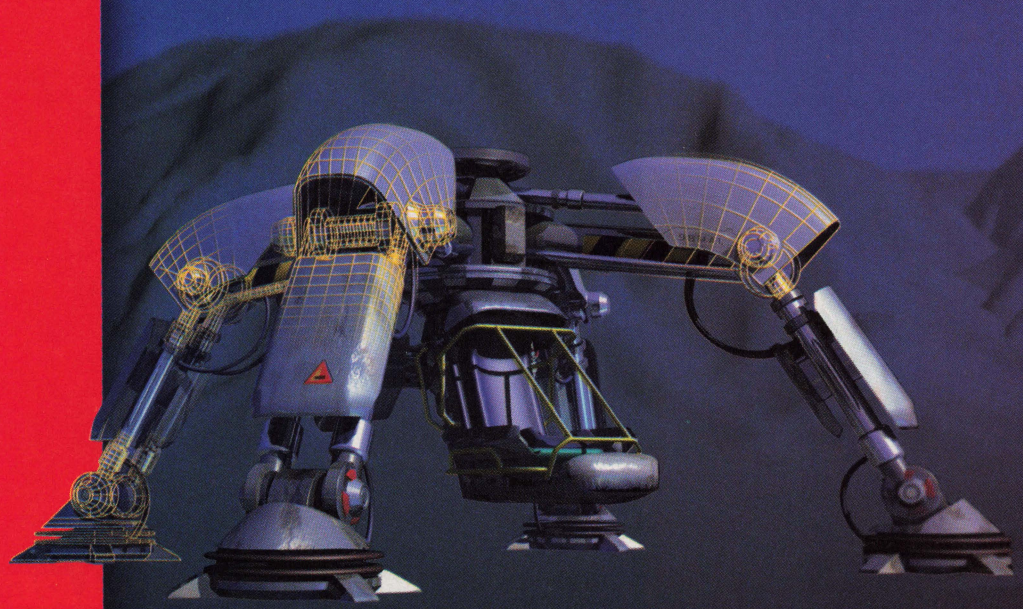

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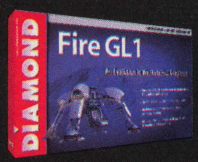

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DIGITAL EFFECTS
UNIX The 5.1 release of Avid Technology's Media Illusion provides tighter integration with Media Composer and Symphony and integrates Avid Marquee software as a plug-in. Artists can automatically conform a broader range of effects than was possible in previous versions, including drop shadow, picture-in-picture, push/peel, and conceal/L conceal. With Marquee, artists can generate layered 3D titles, extrude text, and add texture and lighting. The software also supports all standard sample frequencies when reading audio files. Optional third-party plug-ins include Keylight, a keyer plug-in from The Foundry, and Sapphire plug-ins 2.0 from Genetic Arts. Pricing begins at $24,800. (Tewksbury, MA; 978-640-5059; www.avid.com)
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SHAKE IT UP
WIN/IRIX New keying and masking tool features and improved control functions highlight the Version 2.1 release of Shake, the compositing software from Nothing Real. Users can add a mask to any node in a compositing tree, thereby limiting and controlling the effects of any image-processing operation. With the addition of auto-keyframing, workflow is improved because users can modify animation parameters without having to interact directly with the curve editor. And the program's defocus operator has been designed to better mimic the optical effect that occurs when a lens viewing a particular scene is thrown out of focus. The price for a network license is $9900. (Venice, CA; 310-664-6152; www.nothingreal.com)
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SCIENTIFIC VISUALIZATION

HIGH-END IMAGING
WIN Version 2.0 of Able Software's 3D-Doctor software improves image segmentation to generate object boundaries from image slices and creates 3D rendering in a few steps. Users can import 3D contour data directly into the software for 3D surface rendering and modeling without using an image. New algorithms for 3D image restoration and de-blurring use maximum entropy-based deconvolution methods. An automatic image-slice alignment function enables users to correct image misalignment automatically using a maximum likelihood image-matching technique. A fully functional trial version is available at the company's Web site. (Lexington, MA; 781-862-2804; www.ablesw.com/3d-doctor)
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WEB TOOLS

SITE BUILDER
WIN A free online service for hosting and building media-rich personal Web sites, NanoHome from Nanocosm incorporates interactivity, animation, streaming media, and 3D content. Users must register to obtain a NanoHome, at which time software that supports 3D editing and viewing capabilities is downloaded. A related service offered by the company is NanoLand, a virtual 3D community consisting of neighboring NanoHomes, businesses, and special interest locales. (Foster City, CA; 650-345-7400; www.nanohome.com)
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The Products section is written by Contributing Editor Laureen Belleville.

EVENTS

JULY

20-23 · MacWorld, held in New York. Contact: IDG (800-645-3976); www.macworldexpo.com

AUGUST

5-7 · The Big Picture Conference, held in Orlando, FL. Contact: ST Publications Inc. (800-925-1110 or 513-421-2050); (fax: 513-421-3076); www.bigpicture.net

8-13 · SIGGRAPH, held in Los Angeles. Contact: Smith, Bucklin & Assoc. Inc. (312-644-6610); (fax: 312-321-6878); www.siggraph.org/s99/

SEPTEMBER

13-16 · Computer Technologies Solutions, held with the Detroit Advanced Productivity Expo (APEX), in Detroit. Contact: SME (313-271-1500); (fax: 313-271-2861); www.sme.org

22-25 · digiMedia '99, held in Dusseldorf, Germany. Contact: Dusseldorf Trade Shows (312-781-5180); (fax: 312-781-5188); www.dtsusa.com/dts/

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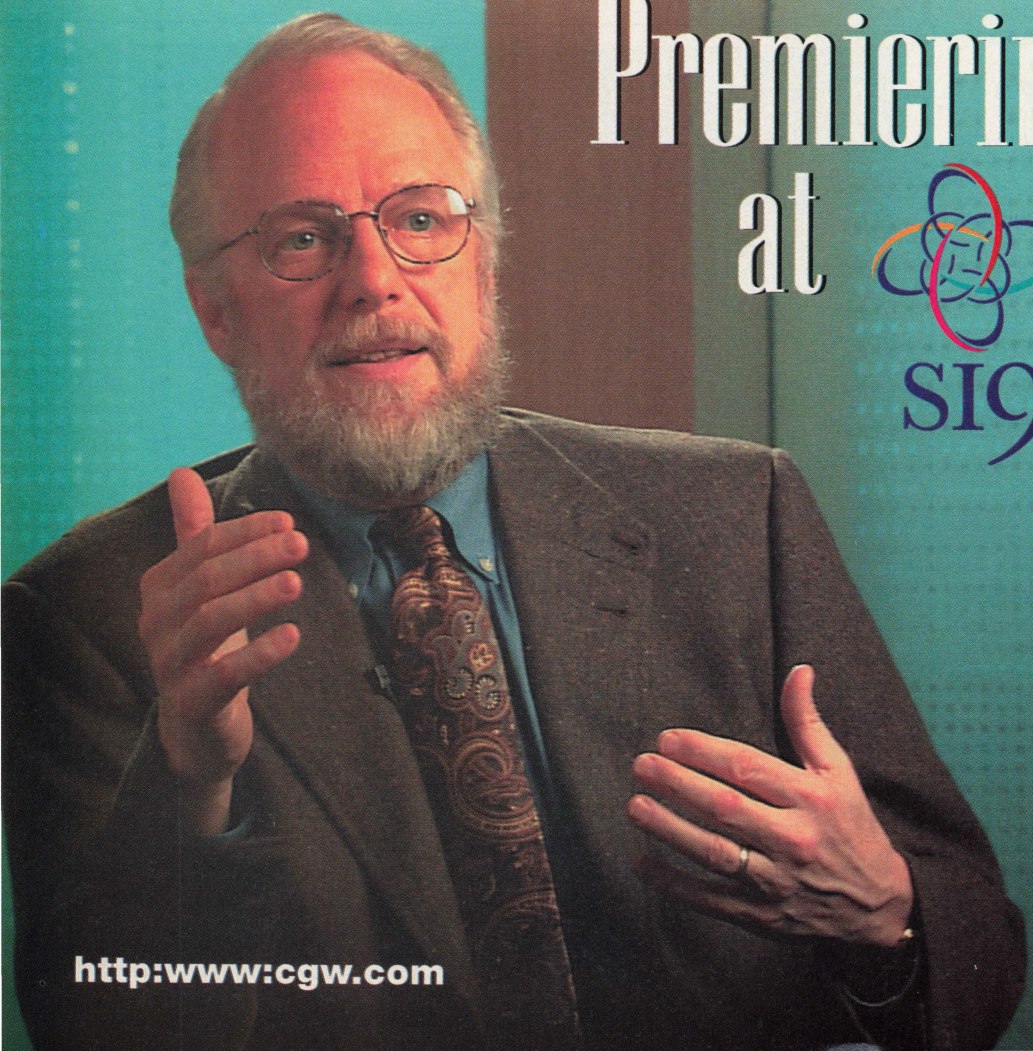

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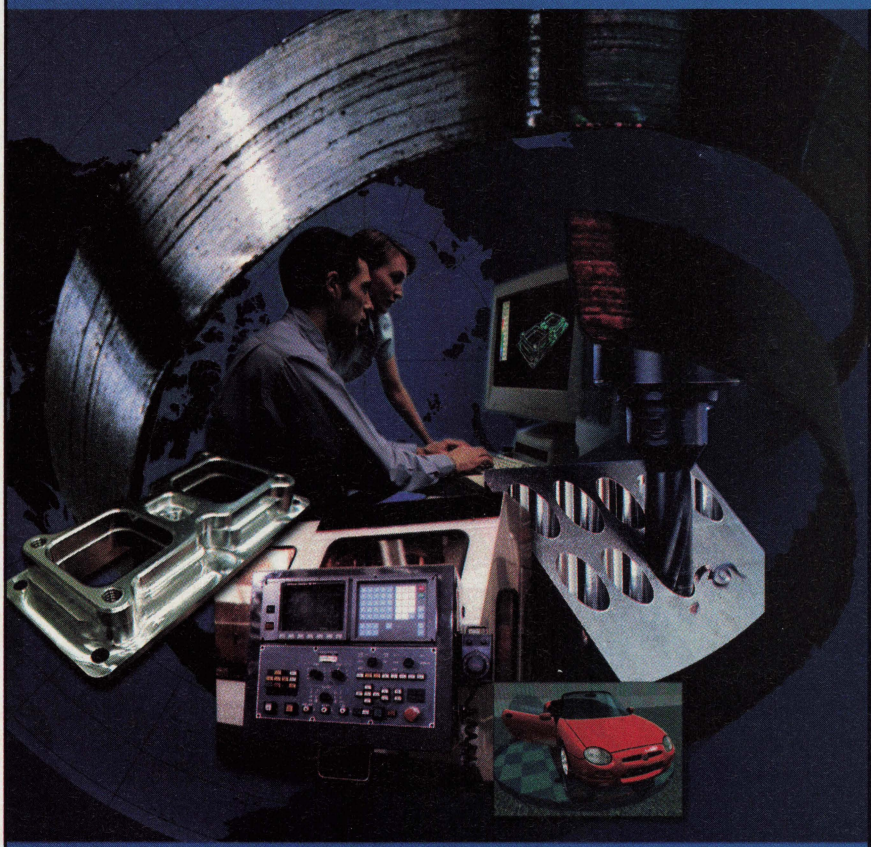

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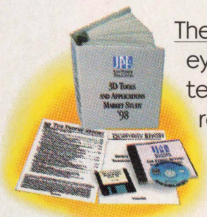

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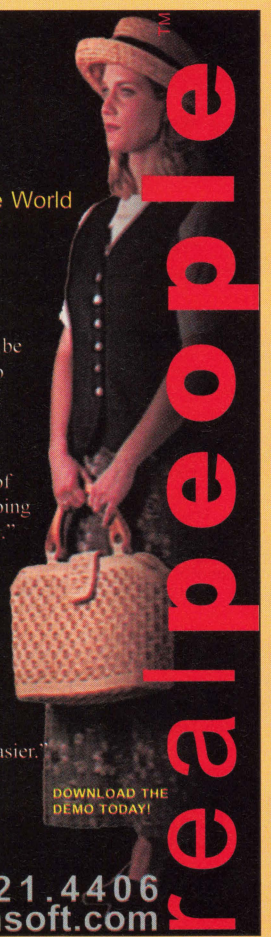

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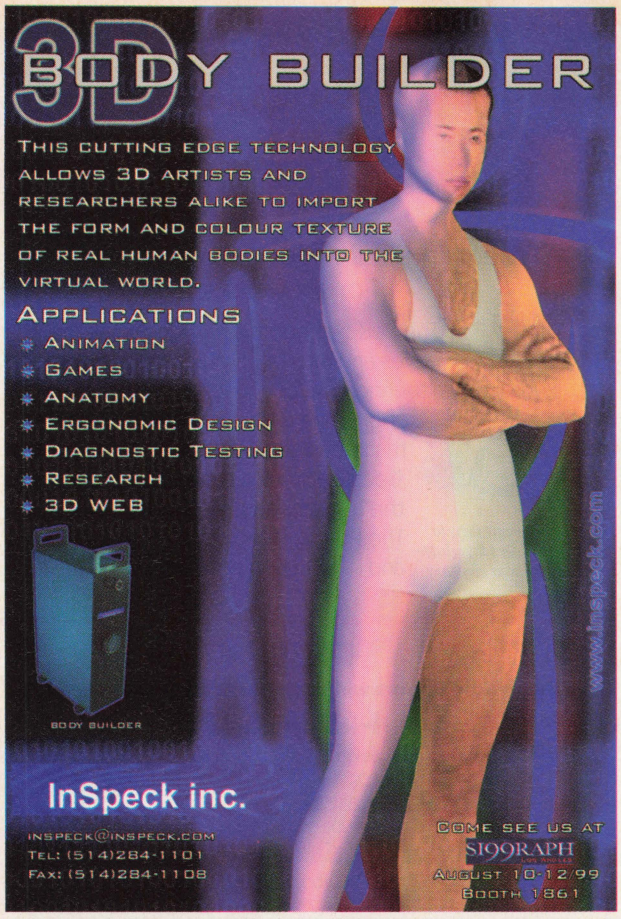

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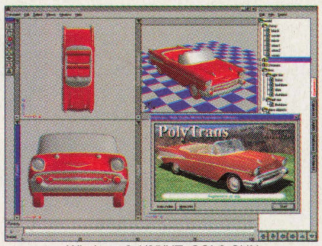

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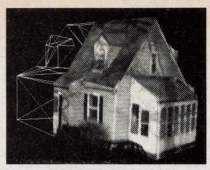

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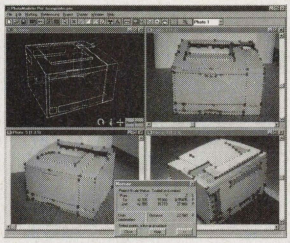

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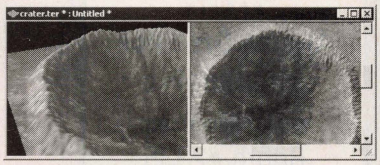

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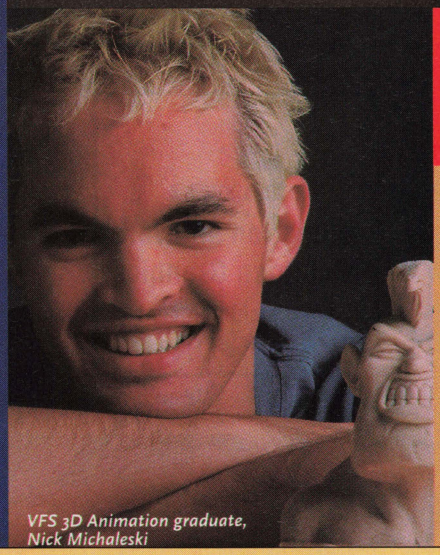

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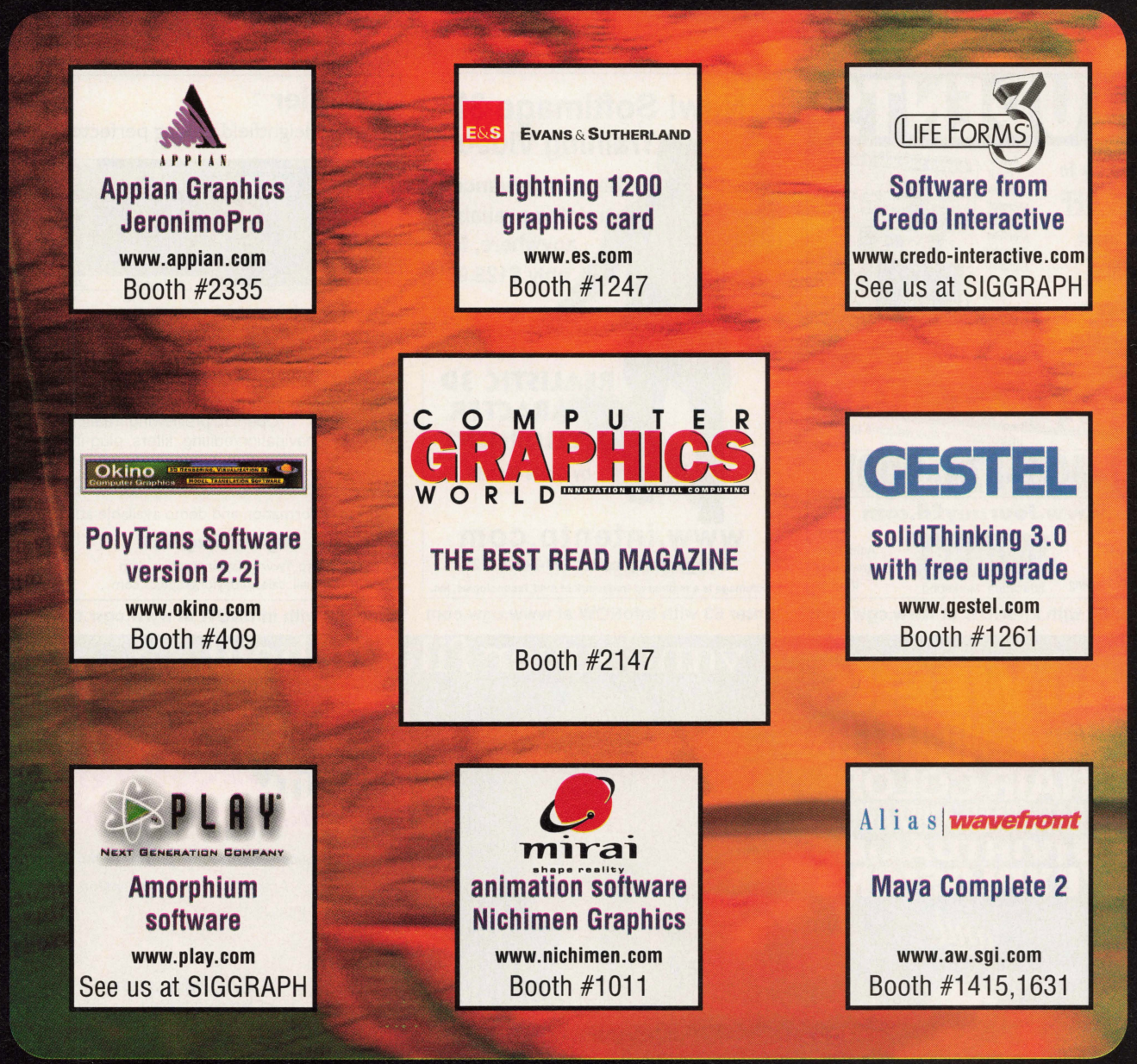

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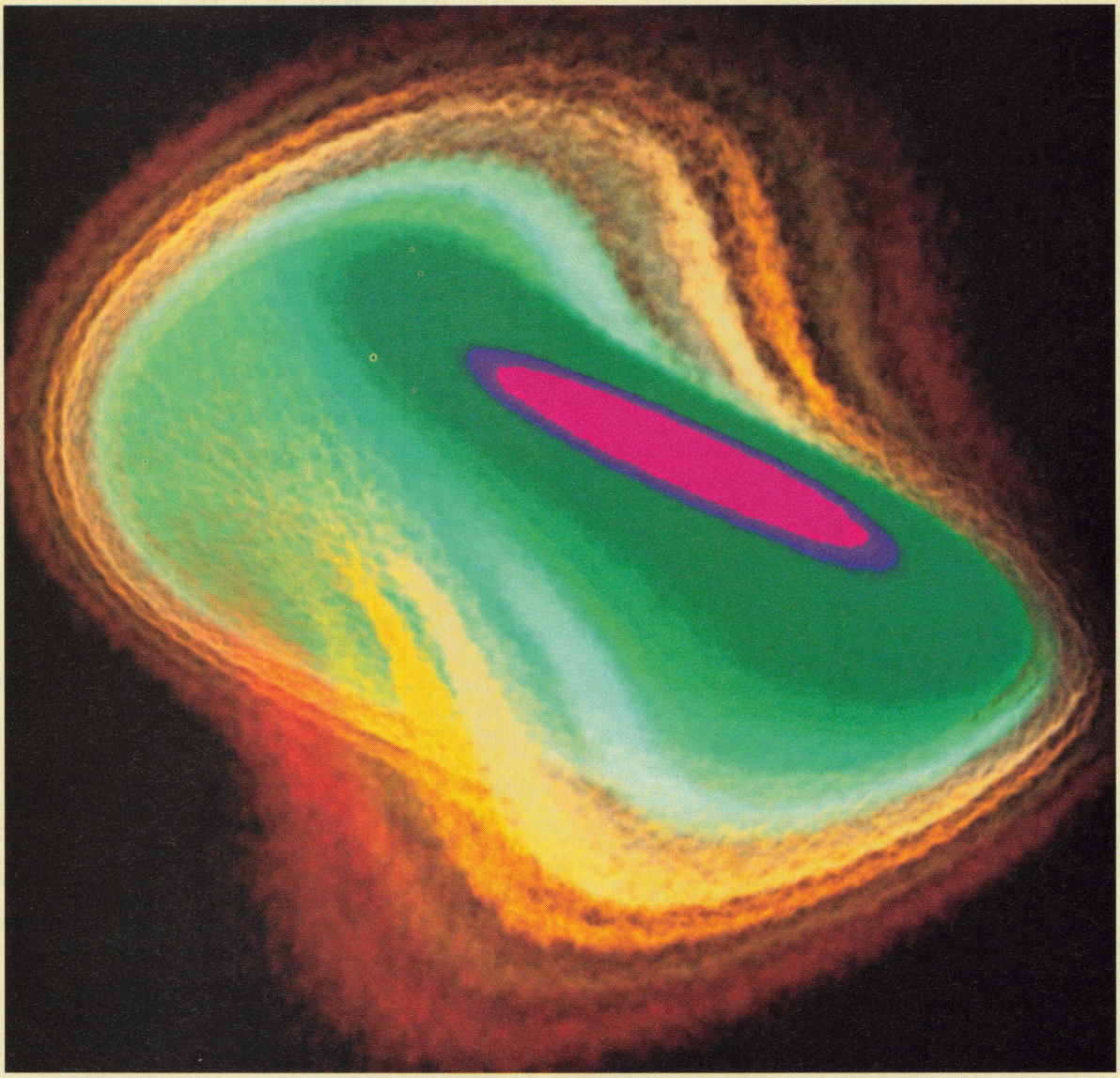

Understanding the density distribution of high-intensity beams in particle accelerators is critical to the development of the next generation of these devices, which are expected to have a significant impact on applications in physics, biology, and materials sciences. Energy production and the transmutation of radioactive waste are two examples of potential accelerator-driven applications. While numerical simulations of particle accelerators can provide scientists with the raw data for an understanding of the beams, visualization tools offer a window into that data. Here, researchers at the Los Alamos National Laboratory (LANL) used visualization techniques to depict the results of a next-generation linear-accelerator simulation. Volume rendering enabled them to see the density distribution of 300 million particles in phase space, a coordinate system in which the third dimension is velocity (in this case, the third dimension is the velocity of particles at one location along the accelerator). To reveal the high-density core of the beam (the purplish region), the researchers "clipped away" about half the particles from the simulation results. Moving out from the center, the colors change relative to the particle density, with the least-dense areas furthest from the center. The scientists developing the underlying accelerator simulation use visualizations such as this to study the "halo" that forms around high-intensity beams and to validate their simulation code by comparing the results to real-world experimental data. Based on the visualization, they can predict the amount of charge that may be lost in the halo, and can effect design changes to improve accelerator performance and reduce risk. Patrick McCormick, a research scientist at LANL, created this visualization using proprietary software, as well as software developed in conjunction with Silicon Graphics. The interactive visualization runs on four SGI InfiniteReality engines. The data was produced by a team led by LANL scientist Robert Ryne.—*Diana Phillips Mahoney*

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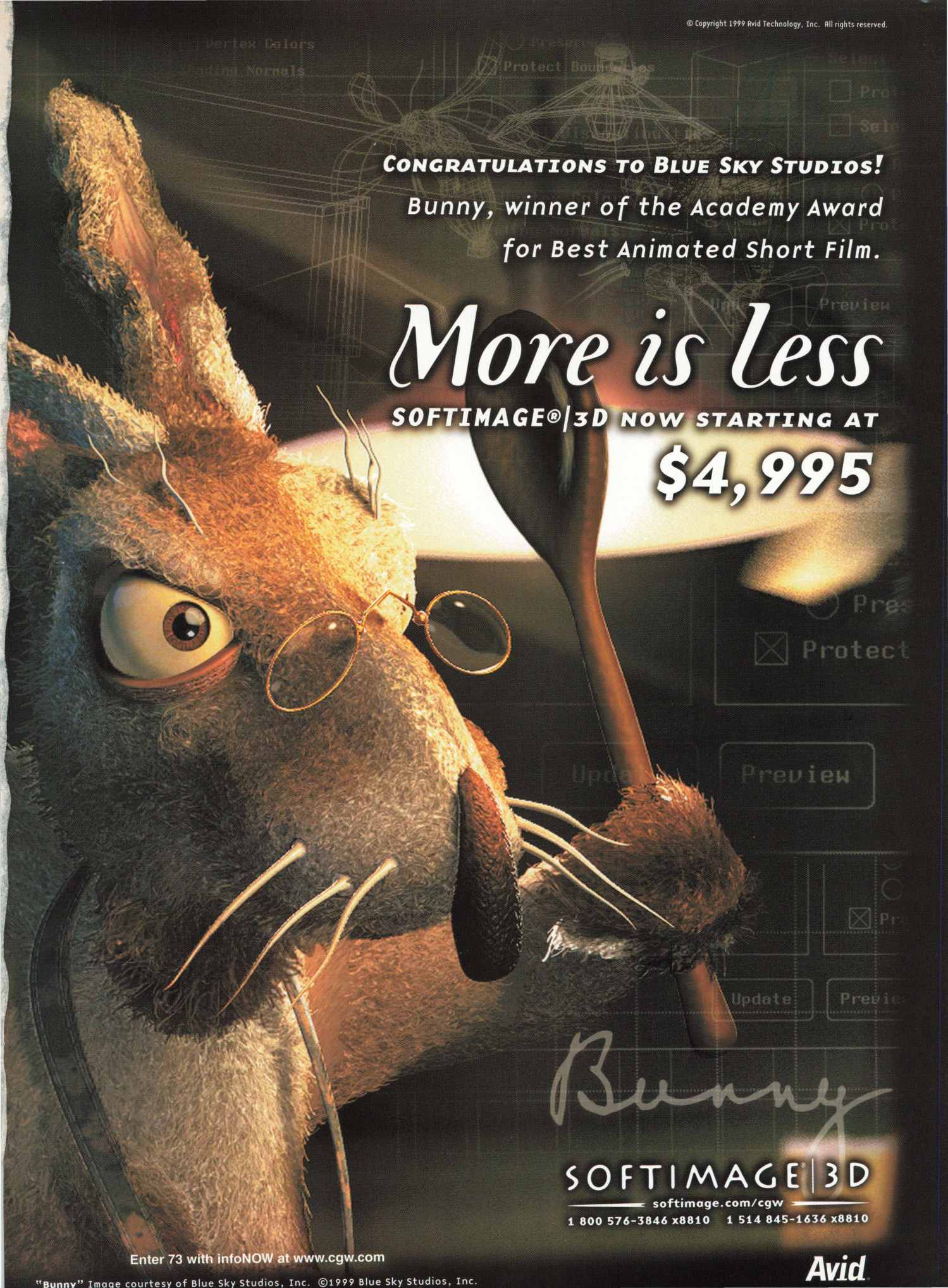

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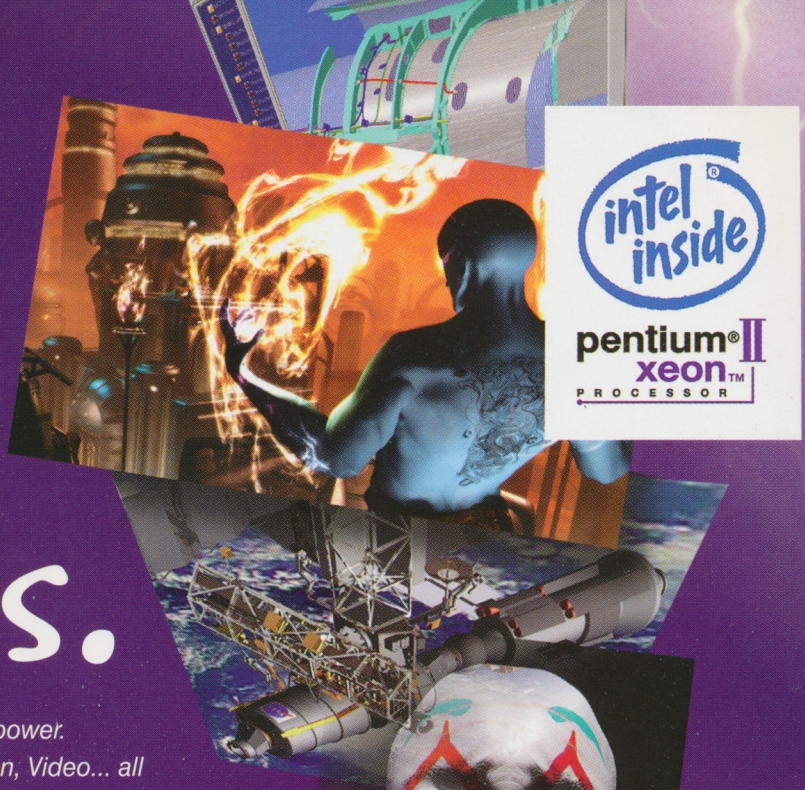

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